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Electric & Hybrid Vehicle System
Research & Development Project

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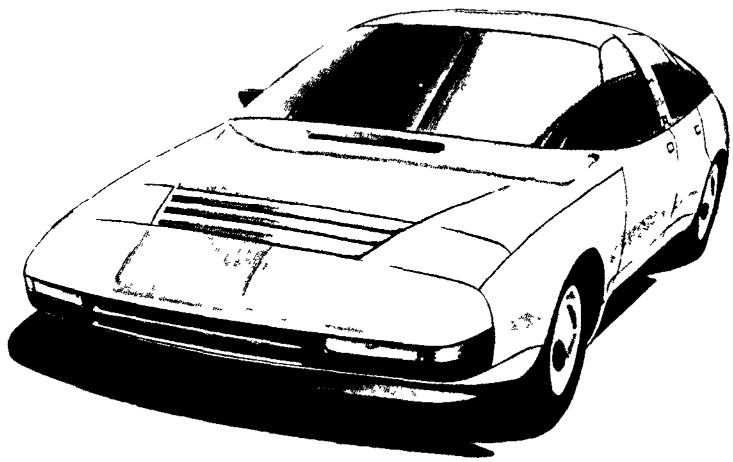
Advanced Vehicle Systems Assessment

Volume III: Systems Assessment



March 1985

Prepared for
U S Department of Energy
Through an Agreement with
National Aeronautics and Space Administration
by
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

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K S Hardy
M A Gyamfi

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ABSTRACT

This report, which is divided into five volumes, documents the evaluation of advanced electric and hybrid vehicles for potential development by the early 1990s. Other volumes include Volume I, the Executive Summary; Volume II, Subsystems Assessment; Volume IV, Supporting Analyses; and Volume V, Appendices.

This volume (Volume III) documents the advanced vehicle systems analyses based on the subsystems technology assessment of Volume II. The systems analyses integrate the advanced component and vehicle characteristics into conceptual vehicles with identical performance (for a given application) and evaluate the vehicles in typical use patterns. Initial and life-cycle costs are estimated and compared to conventional reference vehicles with comparable technological advances, assuming the vehicles will be in competition in the early 1990s. Electric vans, commuter vehicles, and full-size vehicles, in addition to electric/heat-engine hybrid and fuel-cell-powered vehicles, are addressed in terms of performance and economics. System and subsystem recommendations for vans and two-passenger commuter vehicles are based on the economic analyses in this volume. Technical results from this volume, in addition to other subjective measures, are used in the Preference Analyses of Volume IV to develop recommendations for five-passenger vehicles.

Specific areas of analysis addressed in this volume are mission definition, conceptual vehicle design, performance analyses, and cost analyses. In addition, the sensitivity analyses (1) present the results for vehicles designed, using the projections of several battery developers (see Acknowledgment) to provide a different perspective than that of the battery review board, (2) describe the effects of different electric ranges on hybrid vehicles, and (3) show the impact of powertrain cost reduction. Several computer programs were developed to perform the analyses from vehicle concept to life-cycle cost. Their use is described in this volume, and details can be found in Volume V, Appendices.

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The participants in the vehicle systems analyses are shown below with their areas of responsibility:

	Jet Propulsion Laboratory	Consultants
Mission Definition	Govind K. Deshpande	
Modeling/Simulation	Max A. Gyamfi	John R. Brennand Sheldon A. Herman
Synthesis	Keith S. Hardy	

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CONTENTS

SECTION I

METHOD OF ANALYSES

The role of systems analyses in this assessment is to incorporate advanced components in conceptual vehicles, simulate their operation using typical travel patterns, evaluate the vehicles in terms of economics, and recommend further research in support of the most promising nonpetroleum electric or hybrid vehicles (EVs, HVs). The analytical approach is top-down, that is, the performance requirements are the same for all vehicles within a given application (i.e., mission); the vehicle designs vary, depending on specific subsystem capabilities.

The study method, shown in Figure 1-1, illustrates the central role of the systems analyses. Conceptual vehicle designs are formulated from the subsystem characteristics (Volume II) and the performance requirements from the mission definition. The performance is validated on the Federal Urban Driving Schedule (FUDS) with the Jet Propulsion Laboratory/General Research Corporation (JPL/GRC) vehicle simulation program, ELVEC, and further evaluated using a distribution of 24-h driving schedules (to estimate energy consumption in typical annual operation). Initial and life-cycle costs are estimated and recommendations are made, based on relative economics and preference analyses (see Volume IV).

In addition, advanced electric and hybrid vehicles have been designed and evaluated economically with battery performance and cost projections made by developers of the advanced batteries. These results, which can be found in Section IV of this report, provide a different perspective from that of the independent battery review board. Therefore, a range of results has been supplied for interpretation, depending on the reader's level of optimism.

Implementation of the study method is based on computer simulation, for example:

(1) The IBM PC program, AVSIZING, was developed to initially size all vehicle components based on the performance requirements.

(2) ELVEC is used for detailed simulation over driving schedules, using an input file created by AVSIZING.

(3) AVENERGY, an IBM PC program, was developed to statistically combine the ELVEC results from the distribution of 24-h driving schedules and estimate battery life, based on the distribution of daily battery discharge levels.

(4) AVCOST, another IBM PC program developed for this study, uses the vehicle specifications, energy consumption, and battery-life results from the other programs to estimate initial and life-cycle costs.

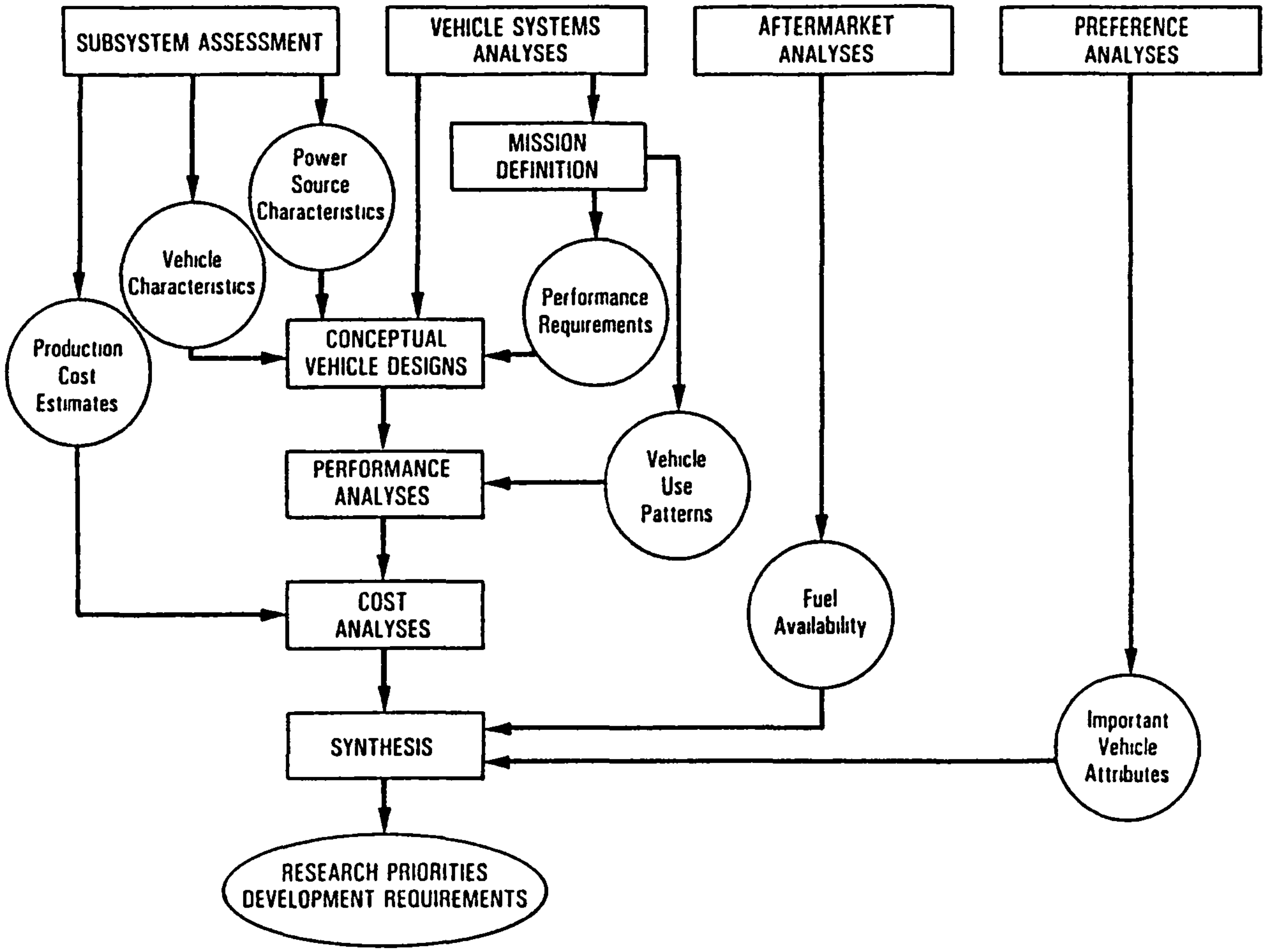

Figure 1-1. Advanced Vehicle Assessment Study Method

(5) Additional programs were developed to support the task, including a curve-fit program that calculates battery model coefficients for ELVEC based on user-supplied battery data, spreadsheet and database programs that display the advanced battery projections, and miscellaneous programs to calculate break-even fuel prices and cost ratios relative to present and advanced technology reference vehicles.

(6) An existing JPL simulation program was used to combine individual preferences and vehicle technical characteristics to rank vehicles in the Preference Analyses.

SECTION II

MISSION DEFINITION

The purpose of mission definition is to identify the expected vehicle performance requirements and usage patterns to allow advanced vehicle (AV) concepts to be evaluated on a realistic basis. Vehicle performance was described in terms of the critical requirements of acceleration, range, and gradability as well as passenger/payload capacity and other vehicle characteristics. The key parameters needed to describe the vehicle usage patterns are well defined driving cycles, trip lengths, daily travel parameters distribution, 24-h daily schedules, and the annual distance traveled. These parameters have been identified through the use of the 1978-1979 Nationwide Personal Transportation Study (NPTS) and projections of travel trends to the next decade.

A. VEHICLE PERFORMANCE REQUIREMENTS

Many powertrain configurations and subsystem alternatives have been considered to overcome deficiencies of the typical EV. To compare vehicle candidates on any meaningful basis requires equalizing as many of the external variables as possible. Thus, the AV requirements were developed, which specify the vehicle capabilities in terms of its transportation function, i.e., on the basis of passenger/payload capabilities and several minimum performance standards. The assumption of internal-combustion engine (ICE) vehicle equivalence for comparison required the development of projected minimum vehicle requirements for the 1990s, based on evolutionary trends. The original set of requirements for full-performance vehicles was circulated to representatives of the auto industry, subsystem manufacturers, and national laboratories for comment. The resulting minimum requirements are shown in the four- to five-passenger vehicle column in Table 2-1. Two-passenger commuter vehicle requirements were established after discussions with representatives of the automotive industry regarding minimum acceptable performance for a limited-use vehicle of this type. The van requirements were based on discussions of preliminary requirements for a van of interest to the Electric Vehicle Development Corporation (EVDC), a conglomerate of utilities supporting the development of electric vehicles.

The acceleration requirement for the full-size passenger vehicles is considered to be "diesel-equivalent," which is obviously acceptable to a large and growing population of drivers even though the performance level is well below that of the average vehicle on the road. The decisions to purchase diesel vehicles were the results of giving up performance in the interest of fuel economy and perceived reliability. It is difficult to predict if more compromise may be acceptable within a decade, but with the continued availability of conventional cars, present-day diesel-engine vehicle performance was used as a likely limit for full-performance vehicles. However, it should be noted that slightly slower acceleration was considered acceptable for commuter electric vehicles. The acceleration requirements for vans was chosen to be consistent with the power necessary for the "van cycle," a modified FUDS with 17% lower peak power.

Table 2-1. Advanced Vehicle Requirements

Characteristics	Van	Passenger vehicles	
Passenger capacity	1 to 2	2	4 to 5
Payload capacity,[a] kg	750	200	400 to 475
Cargo capacity, m^3		0.2	0.4 to 0.5
Acceleration[b] to 88 km/h (s)	27	23	20
Top speed,[b] km/h		100	110
Gradability, %			
at 88 km/h for 5 km	3	3	7
starting from stop		30	30
Range on FUDS,[c] km	96[d]	128	160 to 400
Max refuel time, h	8	8	0.5
Max start-up time, s	30	30	30
Safety	Comparable to conventional vehicles		
Life, yr	10	10	10
km	128500	118860	132360 to 166100

[a]Including passengers.

[b]Test payload of 136 kg for passenger vehicles, 295 kg for vans.

[c]Federal Urban Driving Schedule.

[d]Modified FUDS with the period from 163 s to 346s removed.

The range of 400 km for full-performance vehicles was chosen to correspond to the ninety-ninth percentile daily trip length of the average general-purpose vehicle, to compete with conventional vehicles. This requirement should ease the perception of limited range; however, it is not clear at this time what range is acceptable to the consumer. For example, current four- to five-passenger compact and mid-size cars that are comparable in passenger/payload requirements to the AVs described (i.e., Chevrolet Citation, Pontiac 6000) exhibit ranges of over 600 km (Reference 2-1). On the other hand, General Research Corporation concluded that the best overall combination of range, price, and annual cost for the average motorist results in a range of 200 to 240 km from cars with advanced batteries (Reference 2-2). Therefore, intermediate ranges of 160 and 240 km were investigated for five-passenger vehicles as well. Comments on the commuter vehicle range

indicate that much less range (128 km) would be acceptable for that market. The preliminary EVDC range requirement of 96 km was used although the van cycle was substituted for the less stringent Society of Automotive Engineers (SAE) J227aC schedule.

Two factors that are not obviously important for conventional vehicles, but that can become critical for some AV candidates, are the times needed for start-up and for refueling or recharging. In deference to the known limitations of most AV systems, the times shown in the requirements have been extended to (or perhaps beyond) the perceived limits of consumer tolerance. The minimum recharge times greatly affect vehicle designs as well as the vehicle support systems and infrastructure requirements.

B. VEHICLE USE PATTERNS

The primary objective of this analysis was to characterize automobile travel in the 1990s, based on the 1977 to 1978 Nationwide Personal Transportation Study and projections of trends in vehicle use through the next decade (References 2-3, 2-4, 2-5, and 2-6). Specifically, automobile usage was characterized in terms of travel patterns (distribution of daily travel on an annual basis) and typical driving conditions (driving cycles).

The travel patterns for limited-range passenger vehicles (those with ranges of 128, 160, and 240 km) were derived from those of the full-performance vehicles by truncation of the trip-length distribution beyond the design range. Trip data for commercial vans are not readily available (compared to the NPTS for passenger vehicles), and a simplified, yet somewhat arbitrary, distribution was developed. The discussion of derivational procedures in this section of this report deals with the development of travel patterns for typical, unlimited-range vehicles.

1. Method

A major portion of this effort was the analysis of data contained in the 1978 NPTS. The results of this analysis were compared to the 1967 NPTS to identify possible trends for projection into the 1990s.

The NPTS data are cross-sectional, describing in detail how 18,000 distinct U.S. households used their automobiles on the survey day (24 hours) in terms of trips taken, trip lengths, and trip purposes. This survey was carried out from April 1977 to March 1978; however, each respondent provided data for only 1 day. Data collected included household information related to travel such as population, automobile ownership, and socio-economic variables. The annual mileage driven for each automobile, usually based on a respondent's memory, was also recorded.

The primary purpose of this information is to develop an estimate of travel patterns. An ideal database for such an analysis would be travel diaries describing the details of trips taken by households over extended periods of time, such as a week or a month. However, such longitudinal travel data on a national population sample do not exist in the public domain.

Because longitudinal data are not available, the annual travel patterns were constructed synthetically from the NPTS data by using a Monte Carlo simulation model. The number of trips made by a family-owned vehicle on a given day was assumed to have a Poisson distribution. A travel pattern was synthetically developed by randomly estimating the daily number of trips and their trip lengths from frequency distribution, resulting in daily travel. Daily travel was then accumulated to yield an annual distribution of daily travel distances. This is the "travel pattern" that forms the basis of the vehicle "mission."

Another major aspect of this effort was the development of an extended driving schedule, based on the Environmental Protection Agency (EPA) cycles, to be used to characterize daily vehicular travel for a specific mission. Driving cycles for internal-combustion engine (ICE) powered vehicles are well established, such as the EPA Urban and Highway Cycles and the SAE Metropolitan driving cycles. The characteristics of the ICE permit reasonable comparisons of fuel economy based on the EPA cycles because the engine (power source) and fuel tank (energy source) are virtually unaffected by daily driving distances.

However, the performance of some advanced vehicles could be affected by the daily driving cycle. The state of charge (SOC) of batteries, in most cases, determines the performance capability of an electric vehicle. Most batteries self-discharge thermally or coulombically; therefore, the period between trips and charging can lower the vehicle efficiency. High-temperature batteries and fuel cells are sensitive to the daily driving cycle, especially during the idle periods between trips. Thus, a comparison of the advanced vehicular technologies is more realistic if their performance is measured on the basis of how vehicles are actually used on an hourly basis. The NPTS contains information on parameters such as the times trips started and ended as well as on idle periods between trips, which are used to develop the daily driving cycles. In most studies simulating vehicle performance, it was assumed that a given daily distance was covered by vehicles driving continuously over a combination of driving cycles that added up to the daily distance. The time-tagged daily driving pattern developed by this study should produce more realistic results.

2. Annual Travel Distributions

The NPTS data represent the driving of a sample of vehicles on a given day. The estimate of annual travel patterns should represent the driving of a typical vehicle over a year. The frequently held assumption that one represents the other is probably unfounded.

A basic assumption in developing the travel patterns was that the trip-length frequency distribution reflected in the NPTS is a representation of trip lengths encountered by a typical household. The distribution of daily trips was assumed to be approximated by a Poisson distribution. The average trip length based on the NPTS (1977 to 1978) data was 13.2 km.

Thus, a vehicle making 1,000 trips on an annual basis would be driven approximately 13,200 km, resulting in a mean of 1,000/365 = 2.73 trips per day. Using 2.73 as the mean of the Poisson distributed variable trips per

day, probabilities of making x trips on any given day can be estimated by using the relationship

$$p(x) = e^{-x}/x!$$

where x is an integer with values from 0 to 12, the upper limit of number of trips made by any vehicle on a given day.

The Monte-Carlo simulation consisted of using the daily-trip frequency (number of trips) distribution and the trip-length frequency distribution to develop annual travel patterns. For each day of the 365 days in a year, a random number was drawn to estimate the number of trips on that day. For each trip, the trip length was drawn randomly from the trip-length frequency distribution. By accumulating the daily travel in this manner, annual travel patterns were constructed.

The NPTS data was not sufficiently documented to identify whether a given vehicle was a four- or five-passenger, and the differences in their annual distances could not be estimated; therefore, no differences were assumed. Annual travel projections based on trends are shown in Table 2-2.

Travel patterns were developed for a sixtieth-percentile vehicle with annual travel of 16,000 km, characterizing the general-purpose missions (Figure 2-1). The assumed van travel pattern is shown in Figure 2-2 for 12,850-km/yr operation.

3. 24-Hour Driving Schedules

A primary concern in developing the driving schedules is to describe the driving environment accurately. Several of the battery technologies and fuel cells are affected in terms of energy consumption because of self-discharge and warm-up requirements. The range and energy consumption of these vehicles is affected by the driving pattern. Thus, the 24-h driving schedules were developed to more accurately assess the impact of actual driving time on energy consumption.

Table 2-2. Annual Travel for General-Purpose Vehicle Missions

	Travel, km		
Percentile	1969	1978	1990s
50	16,000	12,800	12,800
75	22,400	20,800	20,000
90	36,800	32,000	30,000

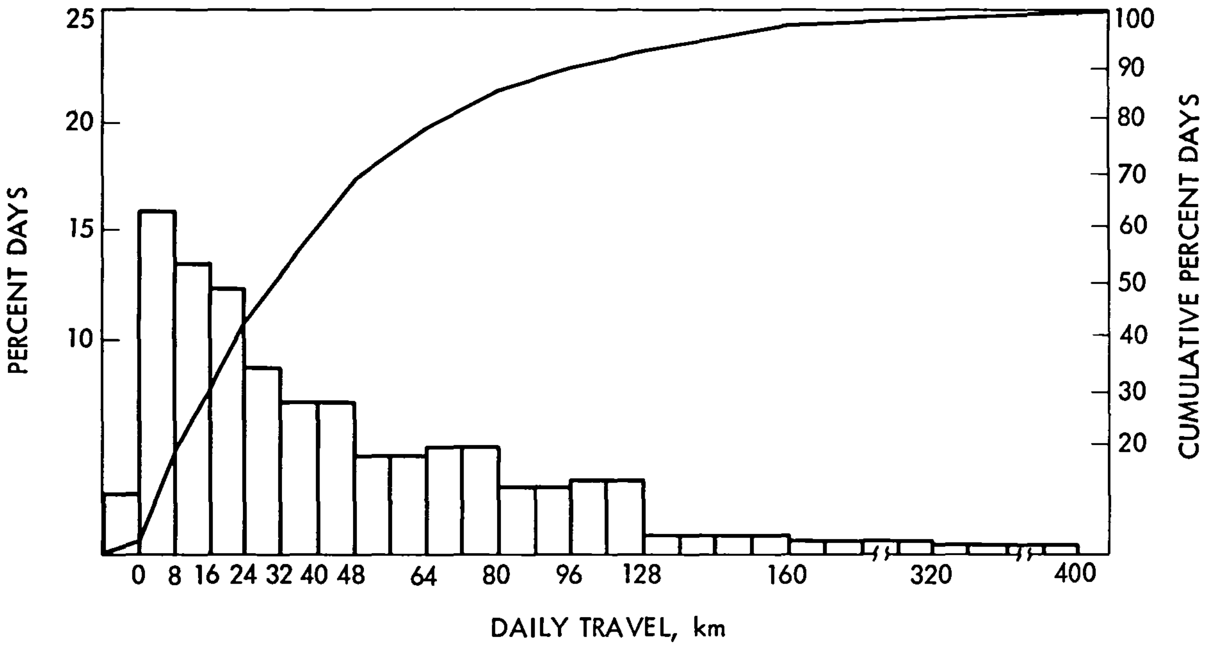

Figure 2-1. Travel Pattern for 16,000-km/yr Passenger Vehicle

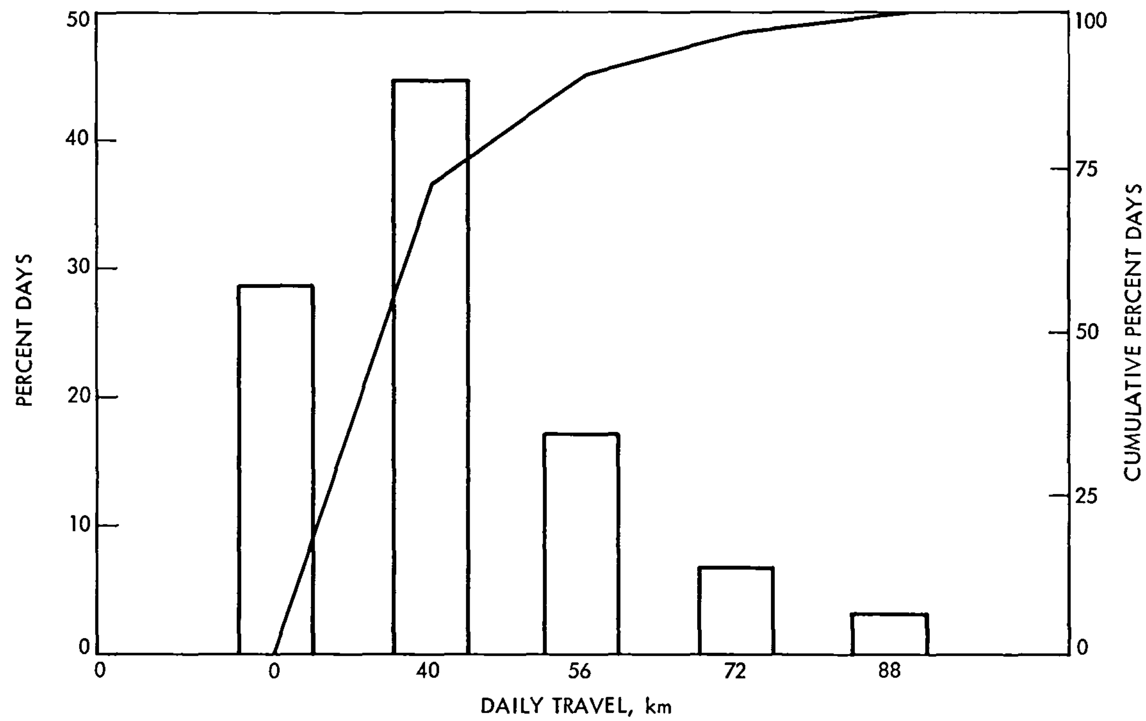

Figure 2-2. Travel Pattern for 12,850-km/yr Van

In an ideal case, the 24-h schedule can be applied to all 365 days, tracking the vehicle movement describing each trip the vehicle makes on the vehicle simulation model. To reduce the complexity and cost of simulation, the annual driving was divided into up to 12 cells describing the daily driving range. The arithmetic mean of each range is assumed to be the approximate distance the vehicle is driven each day. The 12 cells represented distances of 4, 8, 20, 28, 40, 56, 72, 88, 112, 144, 240, and 400 km. Two distributions were developed to describe (1) the starting time of the first trip, based on the number of trips made; and (2) the time between trips when a certain number of trips were made on a given day. Using the Monte-Carlo simulation and these two distributions, 24-h schedules representing travel for 365 days were developed. For each of the 12 daily travel distances represented, a driving schedule was selected (based on the times trips were made and trip lengths).

The chosen trip lengths do not correspond to established driving cycles such as the Federal Highway and Urban Driving Schedules. For trips with lengths shorter than the Urban cycle (approximately 12 km), segments of the cycle were used in developing driving schedules. Complete cycles, either EPA Urban or Highway, were used whenever the trip lengths permitted. A breakdown of Urban cycle segments and descriptions of the 12 (24-h) schedules representing various daily driving distances can be found in Tables 2-3 and 2-4, respectively. Table 2-5 describes the simplified schedule for commercial vans. Note that the park times assumed do not necessarily reflect typical use patterns but were specified to provide the correct relative percentage of vehicle idle time when combined with the repetitive driving schedule (in the interest of self-discharge, etc.).

Table 2-3. Segments of the Urban Cycle

Segment name	Begin time	End, s	Period, s	Length, mi	Speed, mph	
					Average	Max
URB1	0	163	163	0.674	14.9	32.4
URB2	163	346	183	1.960	38.6	56.7
URB3	346	402	56	0.368	23.7	36.5
URB4	402	447	45	0.141	11.3	30.1
URB5	447	510	63	0.448	25.6	36.2
URB6	510	568	58	0.210	13.0	26.0
URB7	568	645	77	0.252	11.8	27.0
URB8	645	693	48	0.168	12.6	26.5
URB9	693	766	73	0.324	16.0	28.6
URB10	766	959	193	1.360	25.4	34.3
URB11	959	1052	93	0.375	14.5	28.5
URB12	1052	1100	48	0.208	15.6	28.3
URB13	1100	1168	68	0.278	14.8	27.0
URB14	1168	1196	28	0.068	8.7	23.5
URB15	1196	1251	55	0.198	13.0	22.0
URB16	1251	1337	86	0.293	12.3	29.1
URB17	1337	1371	34	0.125	13.2	22.9

Table 2-4. Schedules (24-h) for 16,000-km/yr Passenger Vehicle

Cycle											
1	2	3	4	5	6	7	8	9	10	11	12
URB1	URB1	URB1	Fed[a] 1	URB1	Fed 2	Fed 2	Fed 2	Hwy[b] 4	Hwy 4	Hwy 15	Fed 1
URB2	URB2	Pk[c] 5.16	Pk 0.95	to	Pk 1.04	Pk 4.57	Pk 0.82	Pk 7.04	Pk 6.5	Pk 2.61	Hwy 16
Pk 1.9	URB3	URB2	URB2	URB6	URB1	URB1	Fed 2	Fed 1	Fed 1	URB1	Pk 1.0
URB3	URB4	to	Pk 3.44	Pk 7.15	to	Pk 0.60	Pk 0.15	Hwy 1	Hwy 4	URB2	Hwy 7
URB4	URB5	URB6	Fed 1	URB7	URB9	Fed 2	Fed 2	Fed 1	Fed 1	Pk 0.57	Fed 1
URB5	URB6	Pk 0.75		to	Pk 0.87	Pk 2.57	Pk 3.73	Pk 0.66		URB3	
URB6	Pk 5.01	URB7		URB17	URB1	Fed 1	URB1	Fed 1		to	
URB7	URB7	to		Pk 1.56	URB2	Pk 1.38	URB2			URB9	
URB8	to	URB17		Fed 1	Pk 6.83	Fed 1	Pk 0.216				
	URB17	Pk 2.77		Pk 6.87	URB3		URB3				
		URB1		Fed 1	to		to				
		to			URB17		URB17				
		URB9			Pk 1.63						
					Fed 1						
km											
6.7	11.9	19.0	27.0	36.0	55.0	72.0	84.0	118.00	155.0	252	400
Days/yr											
57	50	43	32	63	27	29	18	19	8	7	2

[a]Fed = EPA urban cycle.
[b]Hwy = EPA highway cycle.
[c] Pk = Parked time in hours.

Table 2-5. Schedules (24-h) for 12,850-km/yr Van

Cycle			
1	2	3	4
URB1	URB1	URB1	URB1
URB3	URB3	URB3	URB3
↓	↓	↓	↓
URB17	URB17	URB17	URB17
Pk 1.5	Pk 1.5	Pk 1.5	Pk 1.5
URB1	URB1	URB1	URB1
URB3	URB3	URB3	URB3
↓	↓	↓	↓
URB17	URB17	URB17	URB17
Pk 10.5	Pk 2.5	Pk 1.5	Pk 0.9
↓	↓	↓	↓
Repeat to 40 km	Repeat to 56 km	Repeat to 72 km	Repeat to 88 km
km			
40	56	72	88
Days/yr			
163	62	25	12

SECTION III

CONCEPTUAL VEHICLE DESIGN

A. VEHICLE CONFIGURATION

The primary objective of the conceptual vehicle design phase was to ensure that advanced vehicles with alternate technologies for power sources were compared on a consistent basis. The vehicle configuration section includes common assumptions concerning the drivetrain layout, choice of powertrain subsystems, and the resulting array of vehicles dictated by the technology choices (i.e., different batteries or fuel cells).

The drivetrain layouts are similar for all the vehicles. Front-wheel drive was chosen to be consistent with current trends and to allow more unencumbered space for battery packaging. In all cases, the motor and controls (and engine, when required) are packaged under the hood, and the batteries are located in several areas depending on the weight distribution and space requirements. AC motors and direct drive (with fixed reduction made possible by the high-speed motor) were chosen for the electric vehicles, primarily due to current promising developments and reliability considerations. A four-cylinder engine and continuously variable transmission (CVT) were incorporated in the hybrid vehicles in a parallel configuration. An "either/or" strategy was chosen to simplify the simulation process and limit the differences to energy-storage technologies. The HV drivetrain layout (Figure 3-1) shows how the motive power can be supplied by either the electric drive system or the engine.

No effort was made analytically to justify the choice of the hybrid configuration or the control strategy; however, the objective of the study is to differentiate between subsystem technologies, and the relative merits of the primary subsystems (i.e., batteries) would most likely show up regardless of the control strategy. The overriding assumption concerning the choice of the strategy was the desire to displace a substantial amount of fuel in an

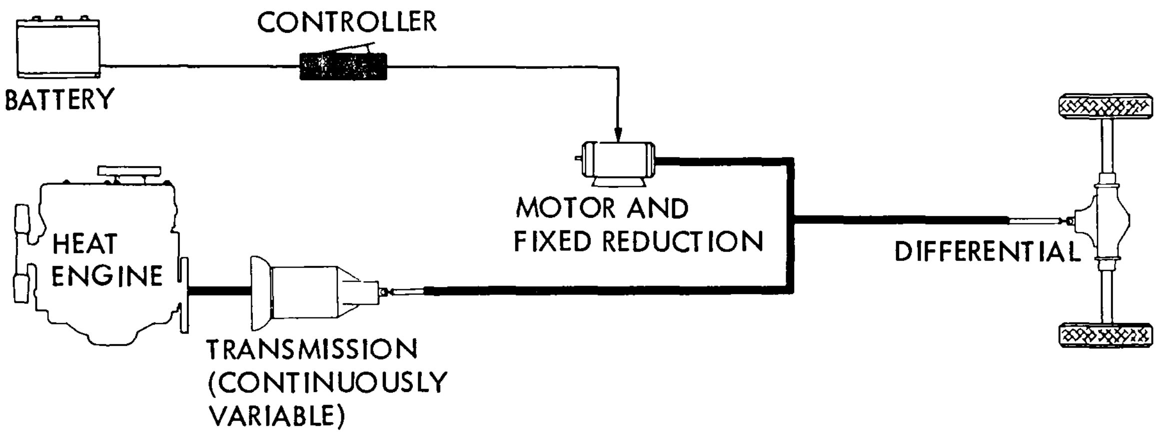

Figure 3-1. Hybrid Vehicle Configuration

efficient manner, and the way to do that is not to use the engine more than necessary. Therefore, initial operation on the electric drive was chosen for 80 km. (Section VI of this report illustrates the advantages of choosing that electric range.) Concerning operation beyond 80 km, an engine running at constant speed connected to a continuously variable transmission is relatively efficient on the Federal Highway Driving Schedule (FHDS), which makes up most of the driving at trip lengths beyond the electric range. Admittedly, the CVT is not critical in this analysis, but current availability of the transmission in the European market made it an attractive choice. At any rate, the parallel hybrid configuration with 80-km electric range on the FUDS and an "either/or" control strategy is common to all HVs of this study.

Perhaps the most obvious subsystem common to the vehicles is the body/chassis. The advanced vehicles are based on vehicles with conventional construction although weight reduction was projected, assuming improvements in efficiency of design and material substitution. The relationship to conventional vehicles was assumed in lieu of costly safety analyses of new designs, in an effort to ensure that AVs would meet the same requirements as their competition. It was felt that AVs would have to take advantage of accepted manufacturing practices at the time if they were to benefit from the economy of high production volume.

The reference vehicles are shown in Figure 3-2.[1] For a given vehicle size, the body/chassis is identical; therefore, all non-propulsion technology is identical (i.e., aerodynamics, rolling resistance, etc.). The AV designs are developed by replacing the internal combustion engine and auxiliaries with electric or hybrid vehicle components and the appropriate structural weight propagation (30% of added weight). A matrix of the resulting vehicle options is shown in Figure 3-3. Note that four-passenger vehicles were not considered further in the analyses. Test runs early in the study showed that no new information concerning the relative merits of the subsystems was to be gained by completing the analyses for four-passenger vehicles in addition to five-passenger vehicles, which provide the comparison to conventional full-size, general-purpose vehicles.

B. COMPONENT SIZING

Consistent component sizing is necessary to ensure that the vehicles meet the primary performance requirements of acceleration, range, and gradability. Vehicle test cases with ELVEC showed that approximately constant power-to-vehicle weight ratios could be used initially to size the components. The most demanding requirement varied with each application, as shown in Table 3-1, which indicates the sizing criteria for each subsystem.

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[1]The body style of the five-passenger vehicle is based on the Lancia Gamma Sedan by Fiat, which was submitted to JPL in their Phase I report of the Hybrid Vehicle Development Project (Reference 3-1). The two- and four-passenger vehicles are similar designs. The van is based on the Chrysler T-van.

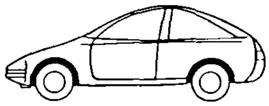
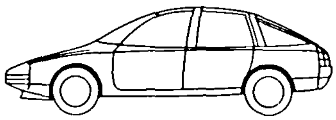
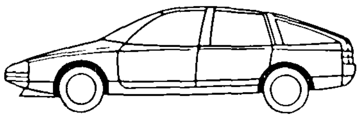
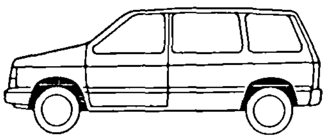
	Curb Weight, kg	Payload, kg	Cargo Volume, m^3	Drag/Rolling Coefficients
 2-Passenger EV	500	200	0.2	0.32/0 01
 4-Passenger EV, HV	670	400	0 4	0.32/0.01
 5-Passenger EV, HV	895	475	0 5	0.32/0.01
 Commercial Van	1080	750	3.6	0 47/0 011

Figure 3-2. Internal Combustion Engine Reference Vehicles

	VAN (96 km)	2-P EV (128 km)	5-P EV (160 km)	5-P EV (240 km)	5-P EV (400 km)	5-P HV (400 km)
Batteries						
Pb/Acid	●	●	●			●
Bip. Pb/Acid	●	●	●	●		●
Ni/Fe	●	●	●	●		●
Ni/Zn	●	●	●	●		●
Zn/Br_2	●	●	●	●		●
Zn/Cl_2	●	●	●	●	●	●
Fe/Air	●	●	●	●	●	●
Li/Fes	●	●	●	●	●	●
Na/S	●	●	●	●	●	●
Al/Air					●	
Fuel Cell						
SPE					●	
PAFC					●	
Heat Engine						
4-cyl. SI						●
Drivetrain						
ac Motor/Inv.	●	●	●	●	●	●
Transmissions						
Fixed Red.	●	●	●	●	●	●
CVT						●

Figure 3-3. Matrix of Vehicles Simulated

Table 3-1. Component Sizing Criteria for Advanced Vehicle Applications

Component	2-P EV	5-P EV	5-P HV	Van	FCV
Battery	26 W/kg (Cycle) and Range	26 W/kg (Cycle) and Range	26 W/kg (Cycle) and Range	20 W/kg (Cycle) and Range	NA
Inverter	26 W/kg (Grade)	28 W/kg (Grade)	28 W/kg (Grade)	20 W/kg (Cycle)	28 W/kg (Grade)
Motor	16 W/kg (0.9 Grade)	25 W/kg (0.9 Grade)	25 W/kg (0.9 Grade)	18 W/kg (0.9 Grade)	25 W/kg (0.9 Grade)
Transmission	26 W/kg (Grade)	28 W/kg (Grade)	28 W/kg (Grade)	20 W/kg (Cycle)	28 W/kg (Grade)
Engine	NA	NA	28 W/kg (Grade)	NA	NA
Fuel Cell	NA	NA	NA	NA	28 W/kg (Grade)

The power level is not the only consideration in sizing the components. The duration of operation at high power levels must be taken into account as well. For example, the grade power is required for 3.3 min, as opposed to the acceleration lasting only 20 to 27 s. It was assumed that the motor could produce twice the continuous power for the time required for acceleration, but only 10% more than the continuous rating for 3.3 min unless external cooling was provided (not assumed in this case). Hence, the motor was sized for 90% of the grade requirement. Power processors (inverters) were not assumed to be as tolerant as motors, and they were sized for the highest power required. The mechanical transmissions (both fixed reduction and CVTs) were sized for the highest requirement as well. Although engines may be operated above their continuous rating for some time, the lack of a thermal model in ELVEC led to a similar assumption of matching the rating to the most demanding requirement. The battery was not as straightforward as the other components because of the simultaneous requirements to meet the power for grade and acceleration as well as the energy for range. The sizing routines and ELVEC were updated to take into account the power capability versus state of charge for all the battery candidates, and the range was adjusted accordingly.

C. VEHICLE DESIGNS

The vehicle design procedure ensures that AVs meet all the performance requirements and that all components can be packaged in the available volume. The procedure of design and validation is semi-automatic in that the initial design is performed on an IBM PC computer, requiring minimal inputs; the

results are validated by submitting a prepared file to ELVEC (submitted by modem to the General Research Corporation). The ELVEC-predicted range must be compared to the desired range and the mass fraction of the battery (BMF) adjusted in the AVSIZING program and iterated to get a better answer, if necessary. This process is shown in Figure 3-4.

The AVSIZING program was developed out of necessity to decrease the time required to make the initial estimate of the vehicle specifications because ELVEC is not a design program and requires an input file describing the vehicle characteristics. The program estimates the BMF required to meet the range requirements (based on previous simulation with ELVEC), which established unique relationships between BMF and range for each battery type and design. Component specifications are determined from the BMF, the subsystem capabilities, and the component sizing criteria (see Table 3-1), taking into account the structural weight propagation and payload requirements. An input file is created and stored for submission to ELVEC. Upon establishing communications with the GRC computer and submitting the file, ELVEC calculates the "actual range," considering the battery energy capacity (using a fractional utilization model) and the battery power capability as a function of state of charge. That is, the range predicted by the fractional utilization model is adjusted by decreasing the range to the point where the battery's 30-s power capability matches that of the peak power required on the cycle. If this range matches the desired range within 5%, the analyses proceed by having AVSIZING create an input file with the necessary information for ELVEC to automatically simulate the vehicle on a distribution of 24-h cycles with different daily travel patterns. Otherwise, a different BMF must be chosen to produce a vehicle that will come closer to the desired range. AVSIZING redesigns the vehicle and prepares a file for submission to ELVEC; the procedure is repeated until the range is met. The details of the AVSIZING program are contained in Appendix M, Volume V.

Tables 3-2 through 3-7 show the results in terms of the vehicle weight, battery weight, depth of discharge (DOD) at the design range, the energy consumption and fuel economy where appropriate. There are notable differences in the DOD (because of the battery power versus DOD capability) and the energy consumption (due to differences in battery efficiency and vehicle weight differences). The impact of battery power capability is explicitly shown in these tables, in the DOD at range. Note the differences between the bipolar Pb/Acid and the others in those applications requiring high power-to-energy (P/E) ratios (i.e., the vans, commuters, and hybrids). The compound effects of the weight differences and the battery efficiency can be seen in the energy consumption.

The sizing routine for the fuel-cell vehicles was not an automated procedure due to the limitations of ELVEC (which simulates only one size system) and the uncertainties concerning the impact of scaling subcomponents on efficiency. The component sizing was based on scaling the subcomponents to meet the vehicle requirements. The details are beyond the scope of this report, but one section of the appendices of this volume describes the assumptions and details the system design and analyses for the solid polymer electrolyte (SPE) and phosphoric acid fuel cells. The comparative analyses of this volume presents only the results of the SPE fuel-cell vehicle because of its superior cost characteristics.

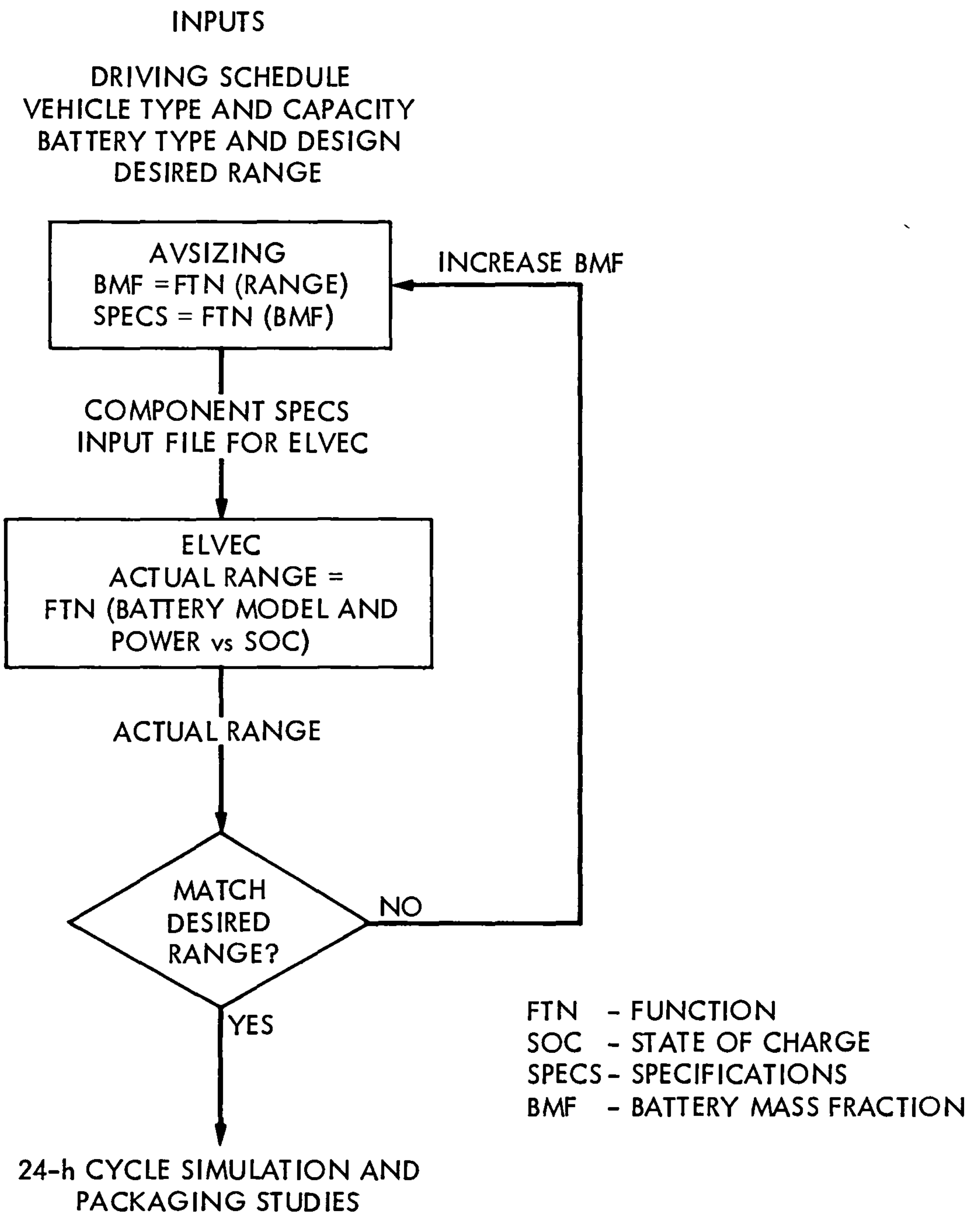


Figure 3-4. Vehicle Design Procedure

Table 3-2. 96-km Van Designs

	Curb weight, kg	Battery weight, kg	DOD[a] at range, %	Wall-plug electric, (Wh/km)[b]
Pb/Acid	1735	453	84	239
Bipolar Pb/Acid	1510	293	95	186
Ni/Fe	1644	388	75	313
Ni/Zn	1455	254	87	230
Zn/Br_2	1722	444	79	378
Zn/Cl_2	1591	350	76	350
Fe/Air	1492	280	83	383
Li/FeS	1486	276	69	279
Na/S	1366	191	82	236
ICE[c] reference	1080	NA[d]	NA	NA

[a]Depth of discharge.
[b]Energy consumption on Van cycle (modified Federal Urban Driving Schedule).
[c]Internal combustion engine.
[d]Not applicable.

Table 3-3. Two-Passenger 128-km Commuter Vehicle Designs

	Curb weight, kg	Battery weight, kg	DOD[a] at range, %	Wall-plug electric, (Wh/km)[b]
Pb/Acid	933	306	90	128
Bipolar Pb/Acid	808	217	96	100
Ni/Fe	849	246	81	161
Ni/Zn	735	165	91	118
Zn/Br_2	969	332	77	206
Zn/Cl_2	878	267	77	189
Fe/Air	788	203	85	203
Li/FeS	743	171	73	142
Na/S	667	118	90	119
ICE[c] reference	500	NA[d]	NA	NA

[a]Depth of discharge.
[b]Energy consumption on Federal Urban Driving Schedule.
[c]Internal combustion engine.
[d]Not applicable.

Table 3-4. Five-Passenger, 160-km Passenger Vehicle Designs

	Curb weight, kg	Battery weight, kg	DOD[a] at range, %	Wall-plug electric, (Wh/km)[b]
Pb/Acid	1768	590	93	212
Bipolar Pb/Acid	1498	404	96	161
Ni/Fe	1545	437	85	258
Ni/Zn	1399	336	93	193
Zn/Br_2	1700	544	89	326
Zn/Cl_2	1499	406	91	290
Fe/Air	1401	338	91	320
Li/FeS	1369	316	80	227
Na/S	1266	245	92	192
ICE[c] reference	895	NA[d]	NA	NA

[a]Depth of discharge.
[b]Energy consumption on Federal Urban Driving Schedule.
[c]Internal combustion engine.
[d]Not applicable.

Table 3-5. Five-Passenger 240-km Passenger Vehicle Designs

	Curb weight, kg	Battery weight, kg	DOD[a] at range, %	Wall-plug electric, (Wh/km)[b]
Pb/Acid	2366	1001	98	268
Bipolar Pb/Acid	2007	754	97	201
Ni/Fe	1875	664	95	301
Ni/Zn	1669	522	94	220
Zn/Br_2	2366	1001	98	447
Zn/Cl_2	1955	746	93	370
Fe/Air	1933	704	94	442
Li/FeS	1565	451	89	251
Na/S	1421	352	94	209
ICE[c] reference	895	NA[d]	NA	NA

[a]Depth of discharge.
[b]Energy consumption on Federal Urban Driving Schedule.
[c]Internal combustion engine.
[d]Not applicable.

Table 3-6. Five-Passenger, 400-km Passenger Vehicle Designs

	Curb weight, kg	Battery weight, kg	DOD[a] at range, %	Wall-plug electric, (Wh/km)[b]
Zn/Cl_2	2203	889	92	404
Fe/Air	1963	724	93	447
Li/FeS	1804	615	92	281
Na/S	1545	437	93	218
Al/Air	1995	746	99	NA[c]
ICE[d] reference	895	NA[e]	NA	NA

[a]Depth of discharge.

[b]Energy consumption on Federal Urban Driving Schedule.

[c]Al/Air battery refueled mechanically.

[d]Internal combustion engine.

[e]Not applicable.

Table 3-7. Five-Passenger Hybrid Fuel-Cell Vehicle Designs

	Curb weight kg	Battery weight kg	DOD[a] at range, %	Electricity/ methanol econ. (Wh/km/mpg)[b]
Pb/Acid	1747	410	77	213/18
Bipolar Pb/Acid	1436	224	94	158/20
Ni/Fe	1618	333	74	273/19
Ni/Zn	1445	229	77	199/20
Zn/Br_2	1783	432	77	333/17
Zn/Cl_2	1685	373	79	319/18
Fe/Air	1537	284	85	338/18
Li/FeS	1517	273	61	248/19
Na/S	1340	167	82	203/21
SPE FCV[c]	1205	216	NA[d]	NA/40[e]
ICE[f] reference	895	NA	NA	NA/23

[a]Depth of discharge.

[b]Energy consumption on Federal Urban Driving Schedule; average methanol mpg beyond 80 km (driving cycles 9 to 12).

[c]Solid polymer electrolyte fuel-cell vehicle.

[d]Not applicable.

[e]Not including warm-up fuel requirements.

[f]Internal combustion engine.

D. VEHICLE PACKAGING

Packaging considerations were necessary to ensure that all the candidate vehicles had adequate space for passengers, luggage, and components. All-electric vehicles required packaging the motor, controller, transmission, batteries, and spare tire. Components for the hybrid vehicles included the motor, controller, transmissions, batteries, engine, gas tank, and spare tire. The space allocated for components and luggage are the underhood space in front and trunk space in the rear for both the two- and four-passenger vehicles and an additional tunnel in the five-passenger vehicle. Vans were assumed to have substantial usable space beneath the floor (with structural modifications). The volumes are shown in Table 3-8.

The size, shape, and location of allocated space were different for the two-, four- and five-passenger vehicles and vans. The vehicles and available volumes are shown in Figures 3-5 through 3-8. The general approach to packaging the subsystems is listed below:

(1) Front-wheel drive was to be maintained.

(2) The front space was utilized first, followed by the tunnel and the rear, to give an overall weight distribution that was front-biased, if possible, but not greater than 70% in the front.

(3) In hybrid vehicles, the engine and batteries were packaged in different locations due to access and maintenance considerations.

Table 3-8. Component Volumes Available[a]

Component locations	Vehicle type			
	2-Passenger	4-Passenger	5-Passenger	Van
Front	290	350	390	500
Tunnel	NA[b]	NA	160	NA
Rear	400	400	450	NA
Beneath floor	NA	NA	NA	1000[c]
Total	690	750	1000	1500

[a]In liters.

[b]Not applicable.

[c]Substantial structural changes required.

(4) The gas tank was placed beneath the rear seat in the four- and five-passenger vehicles and in a similar location in the two-passenger vehicle (below the floor, in front of the rear axle).

(5) The spare tire was placed in the rear.

(6) The battery was located as a single unit beneath the floor of the van, where possible. Although up to 1000 liters (volume in Figure 3-8) could be made available beneath the floor with substantial redesign of the vehicular structure (i.e., much wider frame and independent rear suspension), the volume was not necessary because the largest battery considered was less than 450 liters. Therefore, the batteries were limited to a space 75 cm wide, which is approximately the available space between the primary frame rails of the Chrysler T-van. The batteries were located as far forward as practical (noting the need for driven foot space) in the interest of the weight distribution.

The results of the packaging efforts are shown on the vehicle data sheets in the appendices of this report.

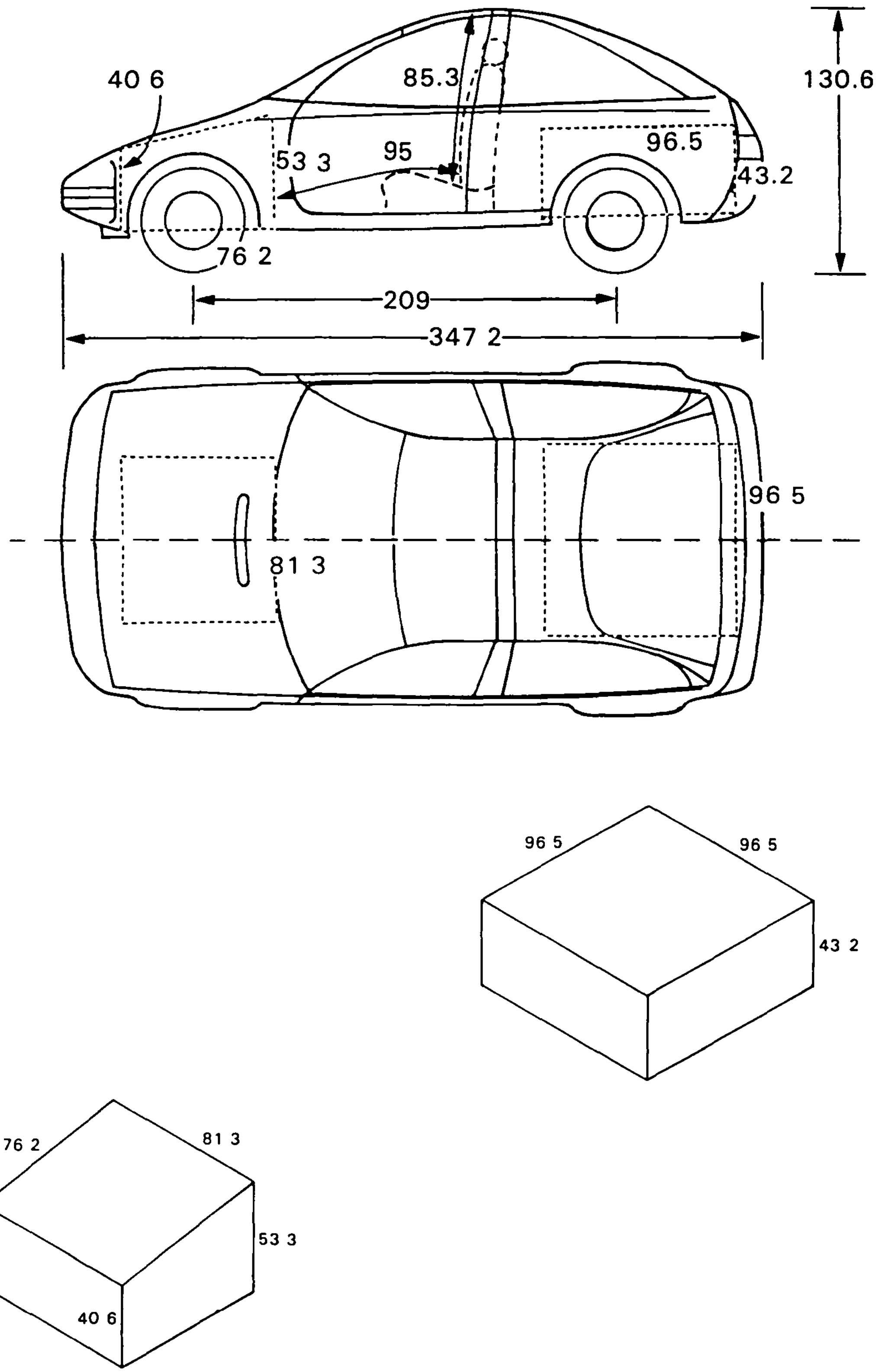


Figure 3-5. Available Component Locations in Two-Passenger Vehicle

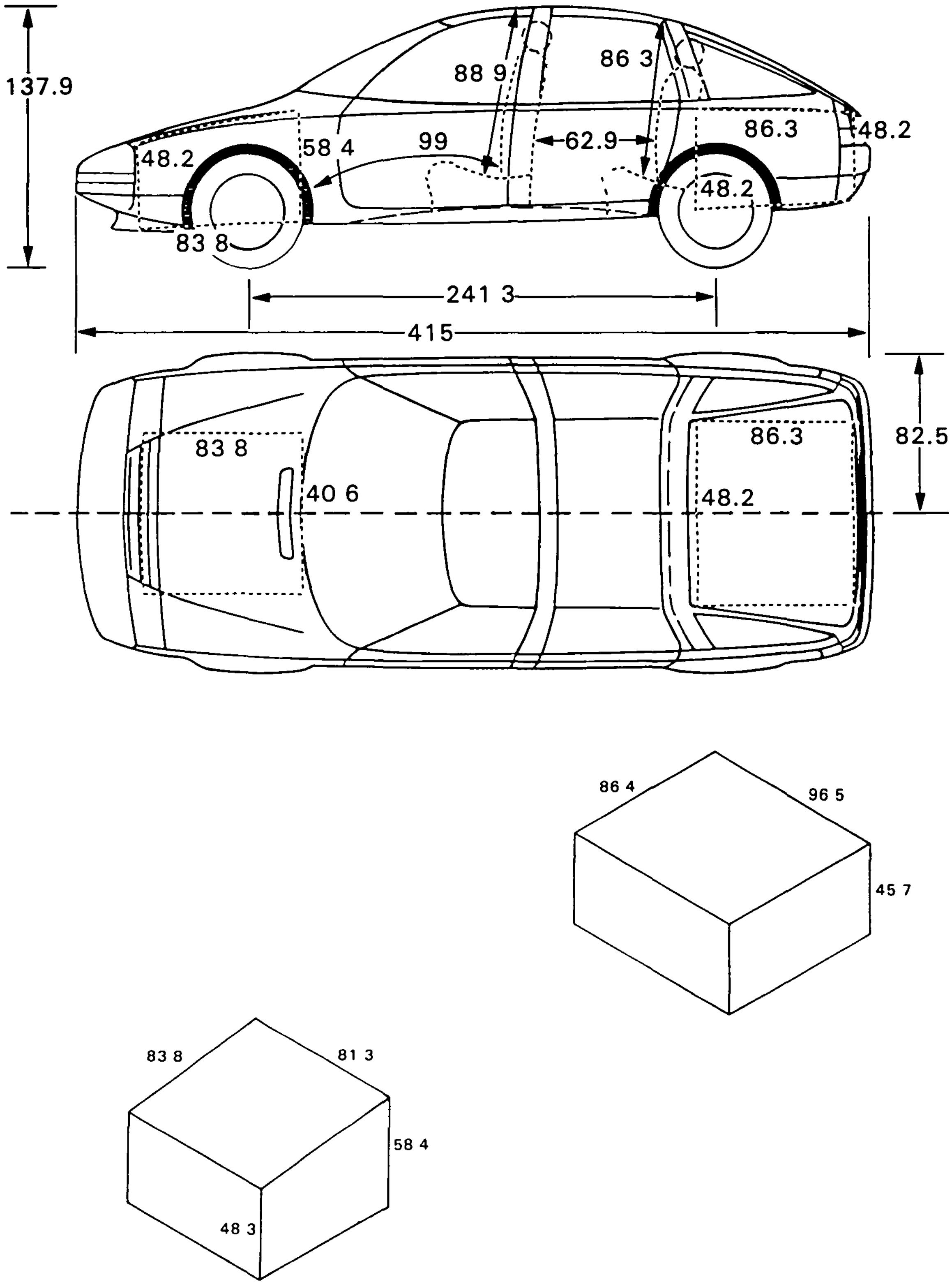


Figure 3-6. Available Component Locations in Four-Passenger Vehicles

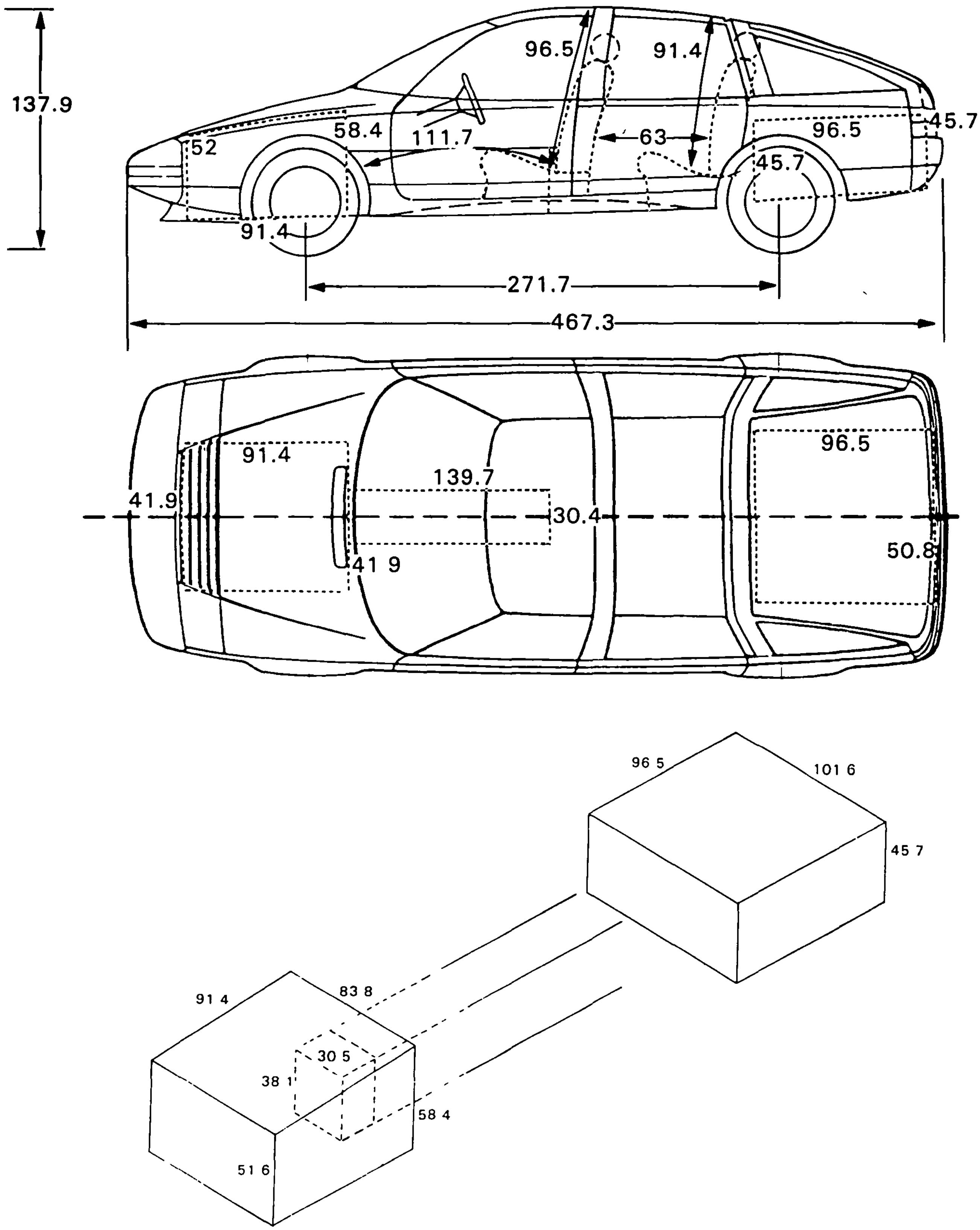


Figure 3-7. Available Component Locations in Five-Passenger Vehicles

Van 6-Passenger

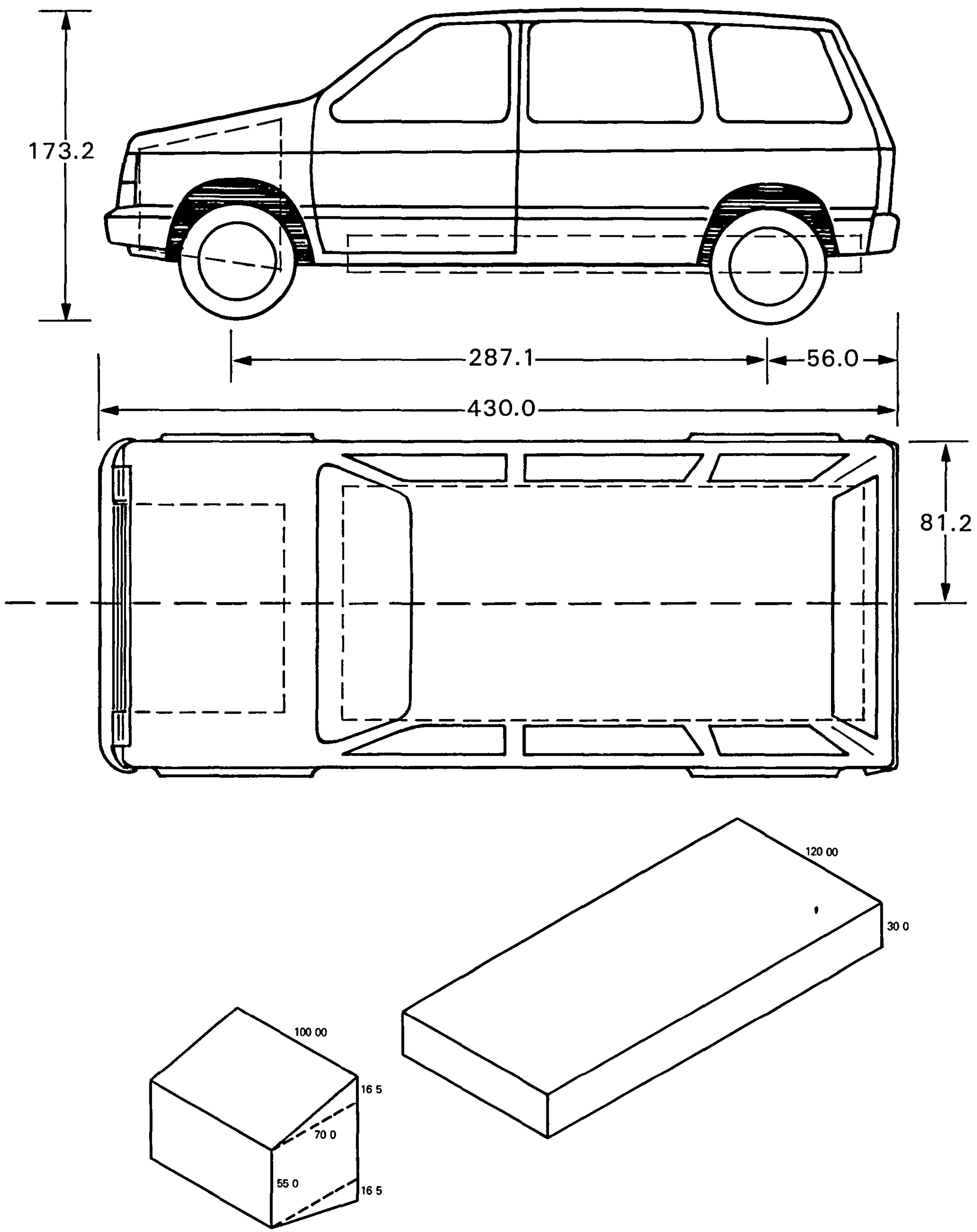


Figure 3-8. Available Component Locations in Vans

SECTION IV

PERFORMANCE ANALYSES

This section deals with battery performance requirements for the various vehicle applications and the results of the vehicle simulation, using 24-h cycles. One objective of these analyses is to determine the effects of propulsion system parasitics (i.e., battery auxiliary and self-discharge power requirements) and different daily travel patterns on energy consumption. Relative energy consumption of vehicles designed for the same application is also presented.

A. BATTERY PERFORMANCE REQUIREMENTS

Battery performance requirements are strongly dependent on the vehicle application, as shown in Figure 4-1, with the requirements for batteries in specific vehicles of this assessment. The specific power and energy correspond to the requirements from the batteries for operation on the FUDS. Lines of constant power-to-energy (P/E) ratios corresponding to the different applications are shown to indicate the dependence on performance requirements. The P/E requirements are essentially constant for vehicle type, and the list below gives the specific values:

Vehicle Type	P/E Ratio
96-km Van	2 to 2.1
2-Passenger EVs	2 to 2.1
5-Passenger EVs	
160-km	1.6 to 1.9
240-km	1.1 to 1.4
400-km	0.7 to 0.8
5-Passenger HVs	
80-km Electric Range	3.3 to 3.8

It should be obvious (see Figure 4-1) that the most desirable battery capabilities would be toward the upper right on each line, that is, with the highest power and energy while maintaining the appropriate P/E ratio. Hence, the points shown for each of the examples are not the optimum requirements, but rather the plots reflect the limitations of each technology. For example, the bipolar Pb/Acid points indicate that it is extremely energy-limited because the high-power capability is not used except in the hybrid case. In other words, the energy capacity is so low (relative to the high power capability) that much more battery power must be used to supply energy for range than is required to supply power for acceleration and gradability. The reverse is true for the lithium/iron sulfide, which is power-limited.

In summary, the P/E ratio is the primary consideration for batteries to meet the requirements of the various applications. The requirements stated are based on the performance that must be supplied to the ac motor assumed,

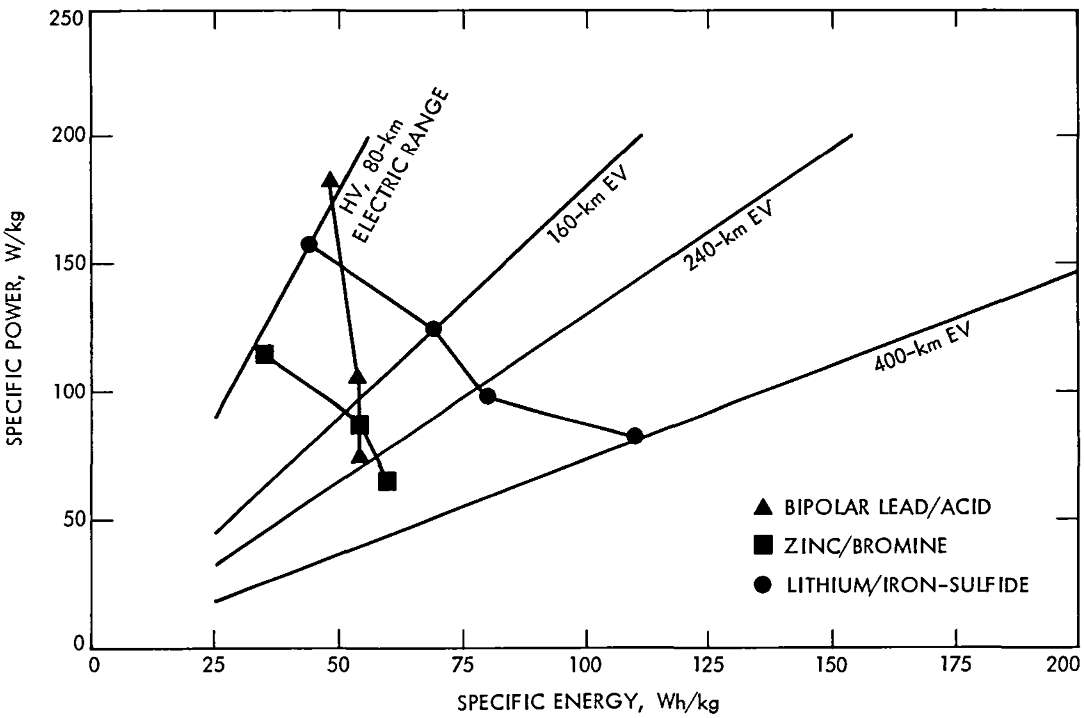


Figure 4-1. Battery Requirements versus Vehicle Application

and the use of a dc system could require 15% higher P/E ratios in some maneuvers requiring maximum acceleration.

B. EFFECTS OF TRAVEL PATTERNS ON ENERGY CONSUMPTION

Twelve daily driving schedules were used to represent the variation in daily driving habits of a typical vehicle (refer to Section II for details). The 24-h driving schedules were developed to aid in assessing the impact of the parasitic losses of many of the advanced batteries or fuel cells. The losses are in the form of auxiliary power (fans, pumps, etc.), coulombic self-discharge, thermal losses due to high-temperature operation, or start-up fuel requirements for the fuel processor of a fuel cell. The assumed values for battery auxiliary power (when the vehicle is operating) and self-discharge (when the vehicle is parked between trips) are shown in Table 4-1. Note that only five of the batteries were projected to have noticeable self-discharge and/or auxiliary power. Some explanation is required for the high-temperature batteries' apparent lack of parasitics even though their heat loss is obvious. The loss is not coulombic, and the electricity required to make up for the lost energy has been considered in the estimate of discharge/charge efficiency. The Al/Air battery self-discharge is accounted for in its discharge curve.

Figure 4-2 shows an example of how the energy is used in a zinc/bromine battery-powered commuter vehicle when operated on the FUDS. When this vehicle was simulated on 24-h cycles, the impact of the parasitic losses were

Table 4-1. Efficiency Characteristics of Advanced Batteries

Battery	Discharge/charge efficiency, %	Auxiliary power, W/kg	Coulombic self-discharge, W/kg
Pb/Acid	75	0	0
Bipolar Pb/Acid	85	0	0
Ni/Fe	58	0	0.016
Ni/Zn	70	0	0
Zn/Br_2	56	1.12	0.080
Zn/Cl_2	53	0.44	0.020
Fe/Air	50	1.67	0.040
Li/FeS	60	0	0
Na/S	66	0	0
Al/Air[a]	50	5.00	0

[a]Efficiency is based on aluminum plates to electricity; self-discharge accounted for in the battery discharge curves.

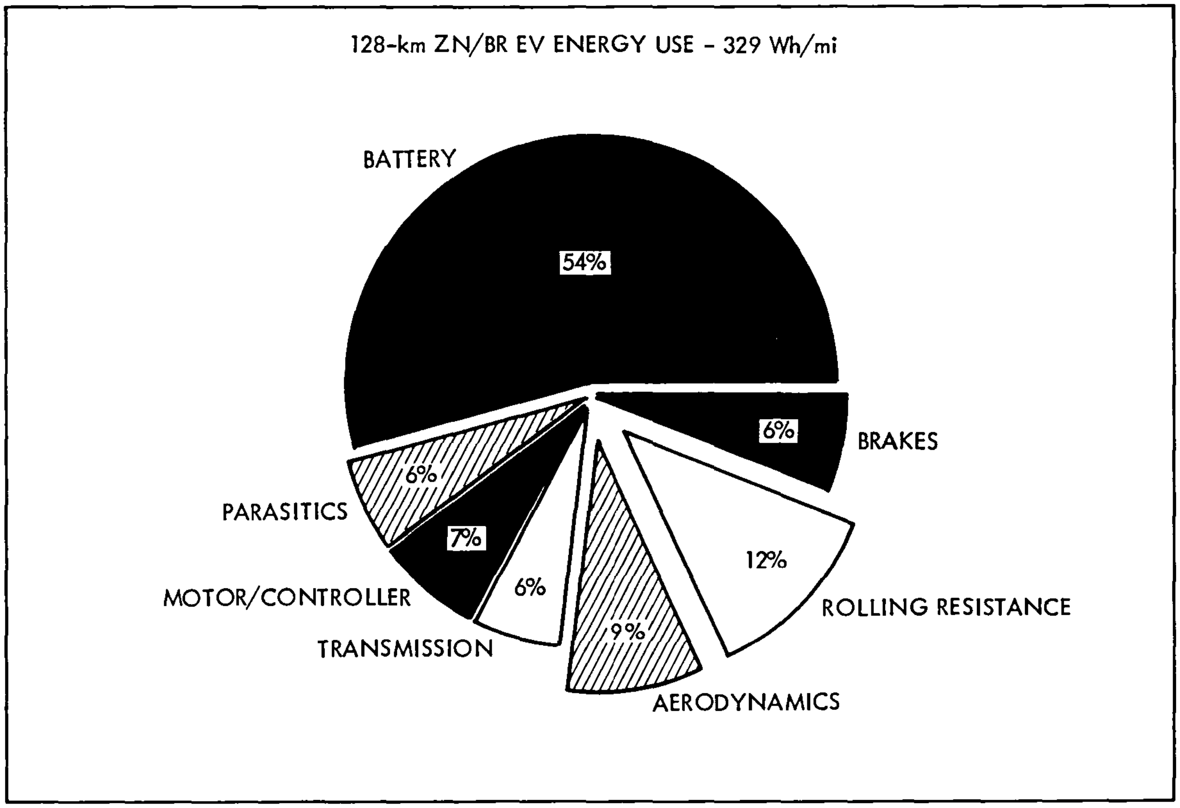


Figure 4-2. Example Energy-Use Characteristics on the Federal Urban Driving Schedule

substantial; in fact, the vehicle was projected to use up to 95% more energy per km on a day with only one short trip (6.7 km). The impact of the losses are lessened as the percentage of time spent driving is increased. This phenomena is shown in the curves of Figure 4-3, which illustrate the energy use as a function of the daily trip length for several battery types (normalized to the energy use on the FUDS). The bipolar lead/acid battery was included to show the impact of the differences caused by driving cycles alone, without the influence of parasitics. This figure implies major differences between the energy consumption on the FUDS and the 24-h driving patterns for specific batteries. A comparison with the average energy use per km (based on annual consumption) is shown in Figure 4-4 as a function of design range, for the same battery examples shown in Figure 4-3. Although the differences are not as great as in Figure 4-3, it is obvious that the more parasitic losses expected from a battery, the more important it is to use detailed energy analyses.

C. RELATIVE ENERGY CONSUMPTION

Electric vehicle energy consumption is significantly related to battery efficiency and is affected by the battery performance capabilities (i.e., the resulting vehicle weight) and parasitic losses. The previous discussion presented the impact of parasitic losses, and the following subsections deal with the relationship between vehicle energy consumption and battery discharge/charge efficiency. The five-passenger, 160-km EVs were chosen to illustrate the correlation. Figure 4-5 shows the ratios of the inverse of battery efficiency, energy consumption, and vehicle weight relative to Pb/Acid. Vehicle energy consumption tracks the inverse efficiency fairly well, with the Zn/Br as a possible exception (although it sustains high parasitic losses that would cause the consumption to be relatively high). Discharge/charge efficiency overshadows vehicle weight as the key ingredient of the relative energy consumption.

Relative energy consumption of all the vehicles is shown in Table 4-2 and summarized with respect to vehicle type in the bar graphs of Figures 4-6 to 4-11. Note that the relative position of one battery to another remains essentially constant despite the application, and the reference line seems to move up or down. This is another indication of the importance of relative battery efficiency.

Concerning the van mission, shown in Figure 4-6, it is notable (even though the electric vans are expected to weigh up to 60% more than the reference van) that the savings in source energy could approach 50%. The flow batteries (i.e., Zn/Br_2, Zn/Cl_2, and Fe/Air) are the least attractive in this respect, because of their low efficiency and high parasitic losses. Most of the commuter vehicles would save substantial amounts of energy as well (see Figure 4-7). The full-size, five-passenger vehicles are not as attractive but can still save energy with some battery types, up to 240-km range. At the 400-km range, only the Na/S battery is expected to remain in the energy-saving category. The Al/Air battery results are somewhat deceptive in that the vehicle is not electrically recharged as the others, and the interpretation of energy efficiency is unique. If source energy is considered with the projected 18% overall efficiency, the vehicle would use over five times the

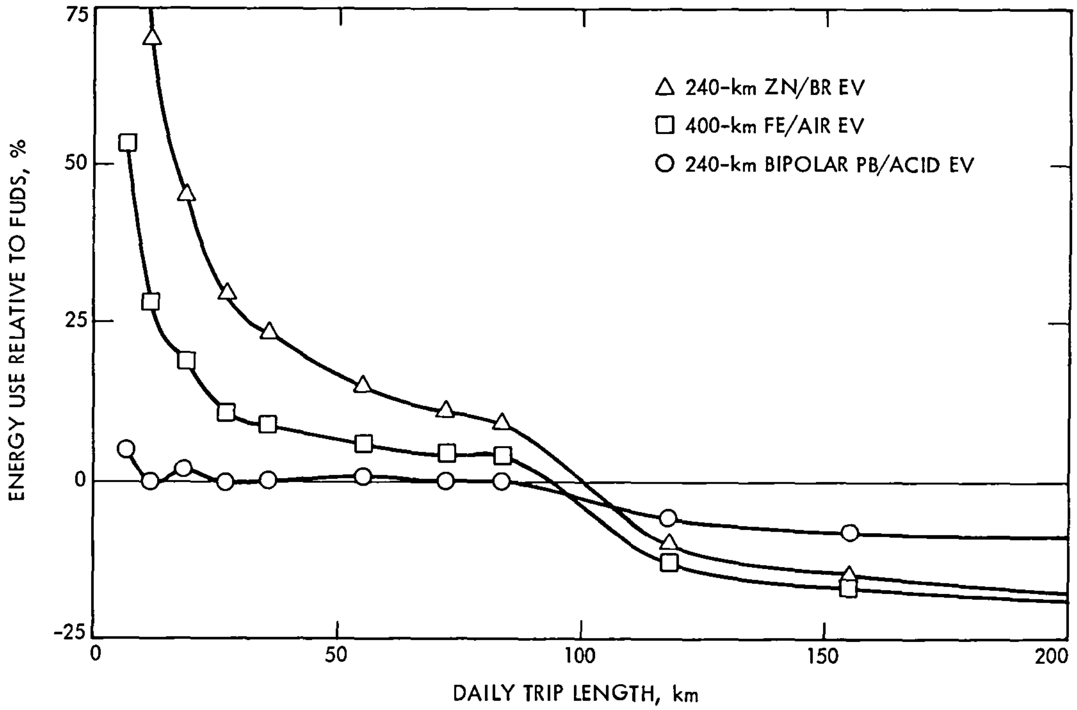


Figure 4-3. Typical Energy Use versus Daily Trip Length

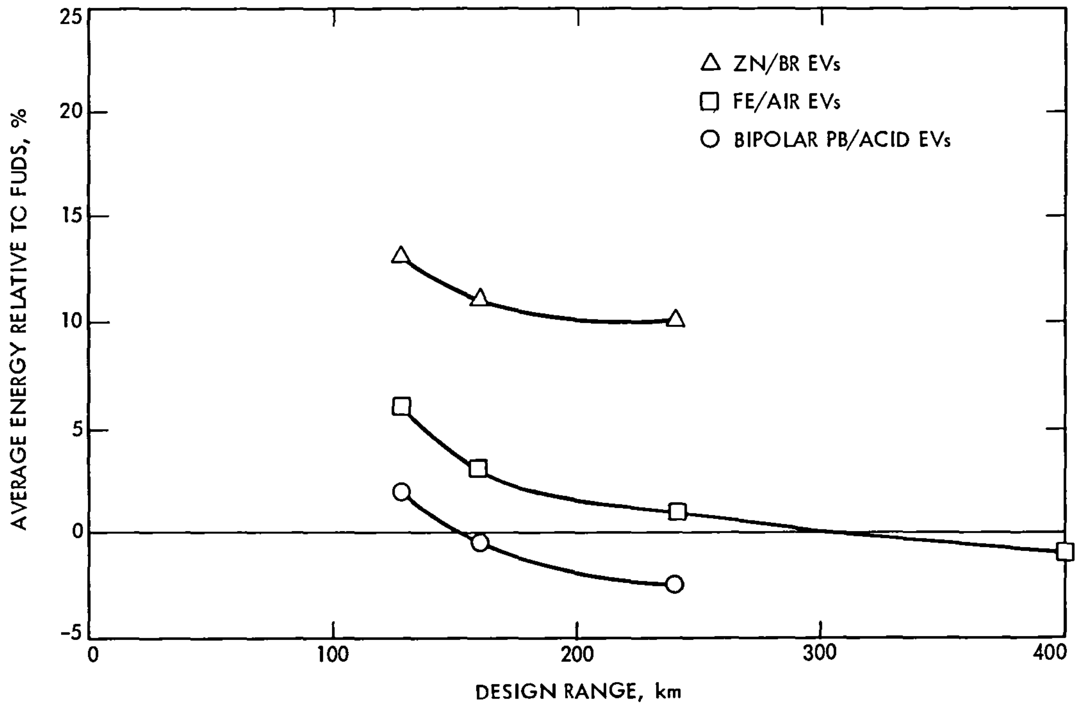


Figure 4-4. Average Energy Use versus Design Range

Table 4-2. Relative Energy Consumption[a]

Battery	Vehicle range, km					
	Van-96	2P-128	5P-160	5P-240	5P-400	HVs, FCVs-400
Pb/Acid	239	129	209	257	NA[b]	214/18
Bipolar	186	102	162	197	NA	159/20
Ni/Fe	317	167	263	301	NA	280/19
Ni/Zn	230	121	192	216	NA	201/20
Zn/Br_2	403	237	366	497	NA	378/17
Zn/Cl_2	355	197	295	368	394	328/18
Fe/Air	391	215	330	445	443	355/18
Li/FeS	279	144	226	246	270	250/19
Na/S	236	122	193	209	218	204/21
Al/Air	NA	NA	NA	NA	538[c]	NA
SPE FC[d]	NA	NA	NA	NA	NA	190/29
ICE[d]	367	177	239	239	239	239/23

[a]Wh/km/mpg.

[b]Not applicable.

[c]Equivalent energy of aluminum fuel.

[d]Equivalent energy based on coal source, 1 gal methanol = 8.8 kWh.

energy of the reference. However, if the battery conversion efficiency of the aluminum plates is used (50%), the relative efficiency looks more attractive at 2.25 times the energy use of the reference vehicle. Either way, energy consumption is not the strong point of the aluminum/air battery.

The advantage of the hybrid vehicles can be seen in the relative energy comparison of Figure 4-11. Although the electric vehicles with comparable range (400 km) saved little or no energy, some of the hybrids could save substantial energy in some cases. In addition, 70 to 75% of the reference liquid fuel could be saved. However, the fuel-cell vehicle is projected to save only 20% of the fuel due to the start-up fuel required, which almost negates the advantage of the efficiency (about three times that of the reference heat engine). Further discussion of the impact of warm-up fuel for the fuel processor can be found in Section VI of this report.

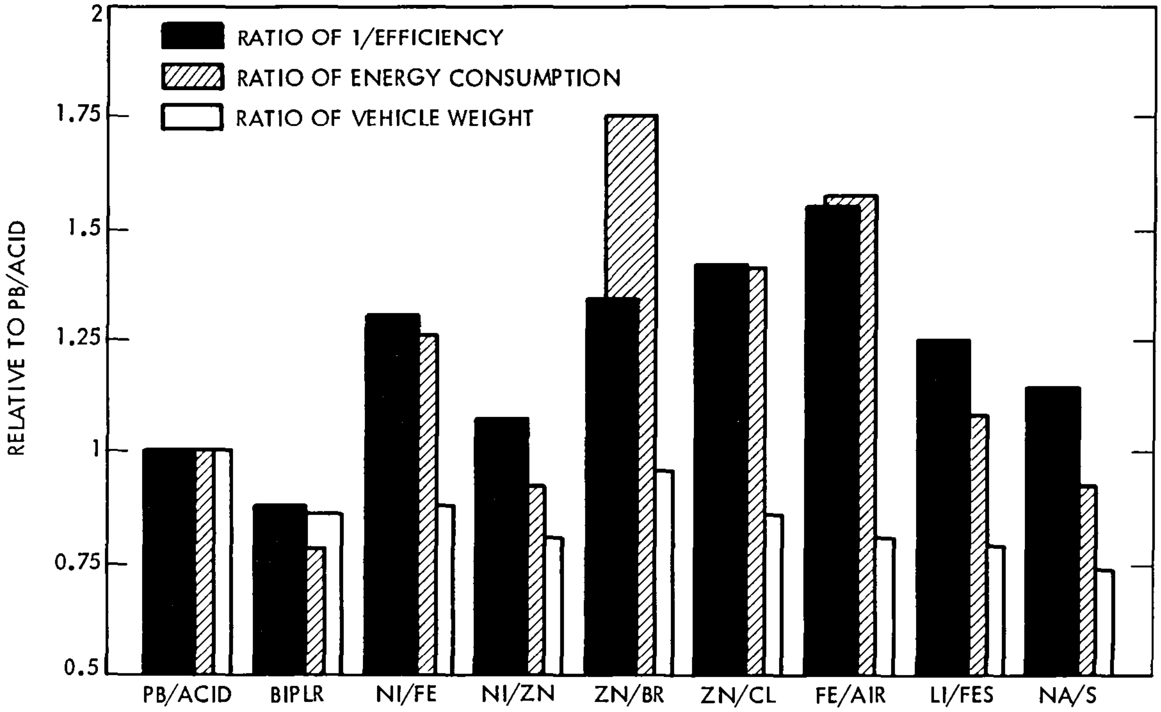


Figure 4-5. Efficiency, Vehicle Weight, and Energy Consumption

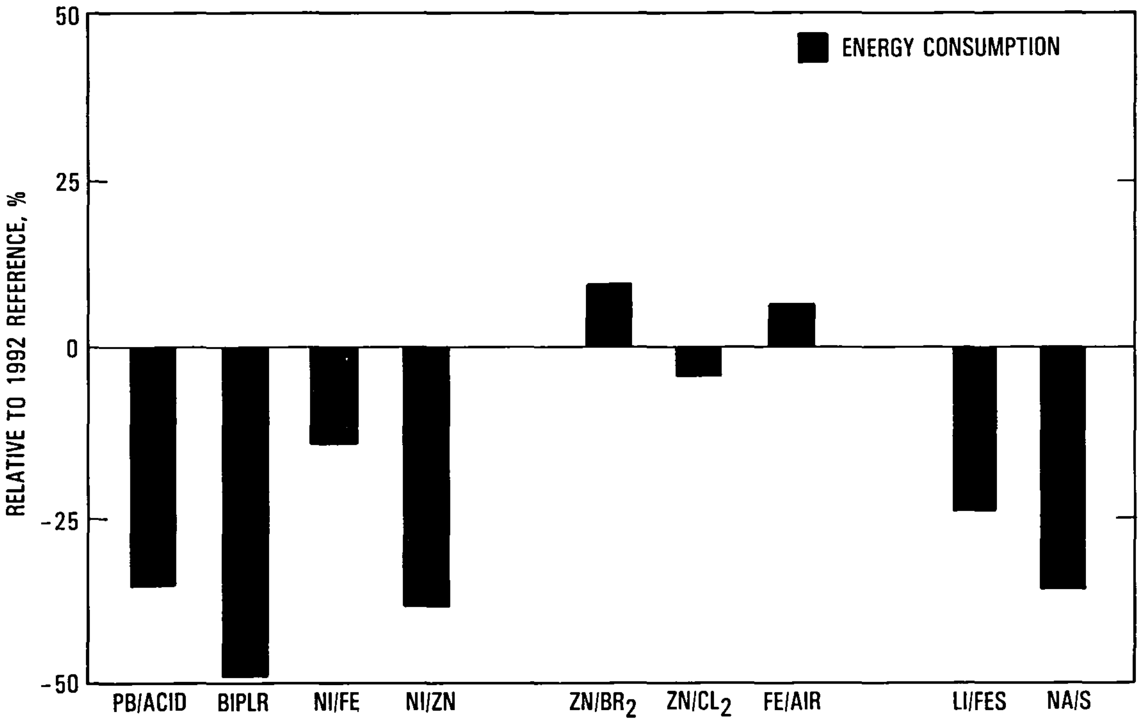


Figure 4-6. Electric Van Energy Comparison

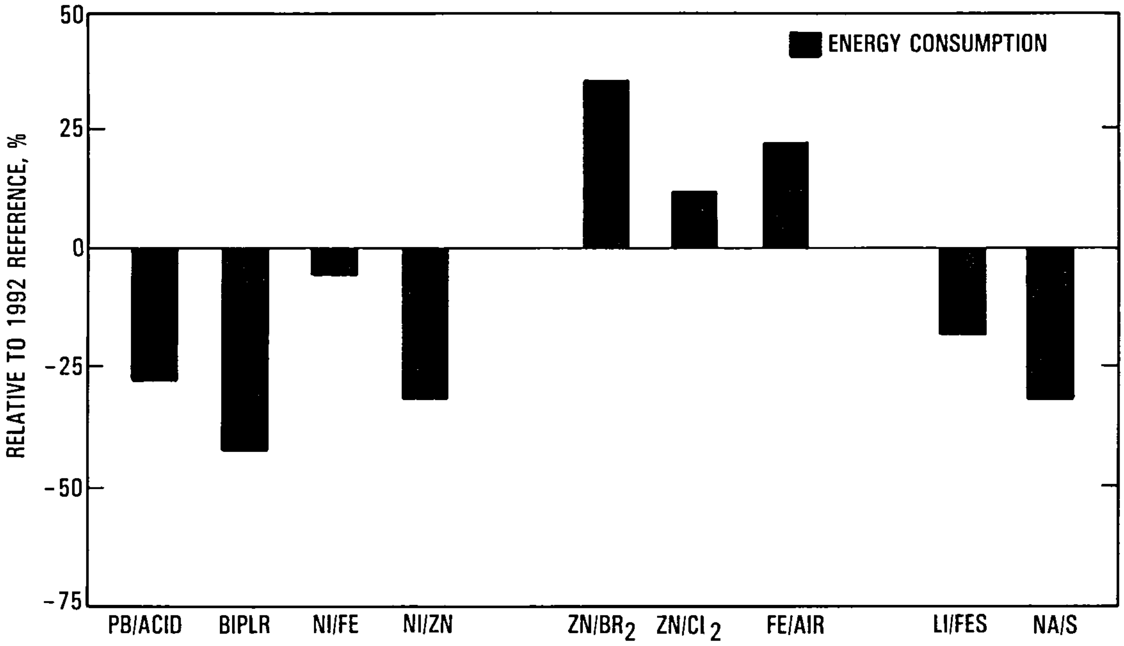


Figure 4-7. Two-Passenger 128-km Electrical Vehicle Energy Comparison

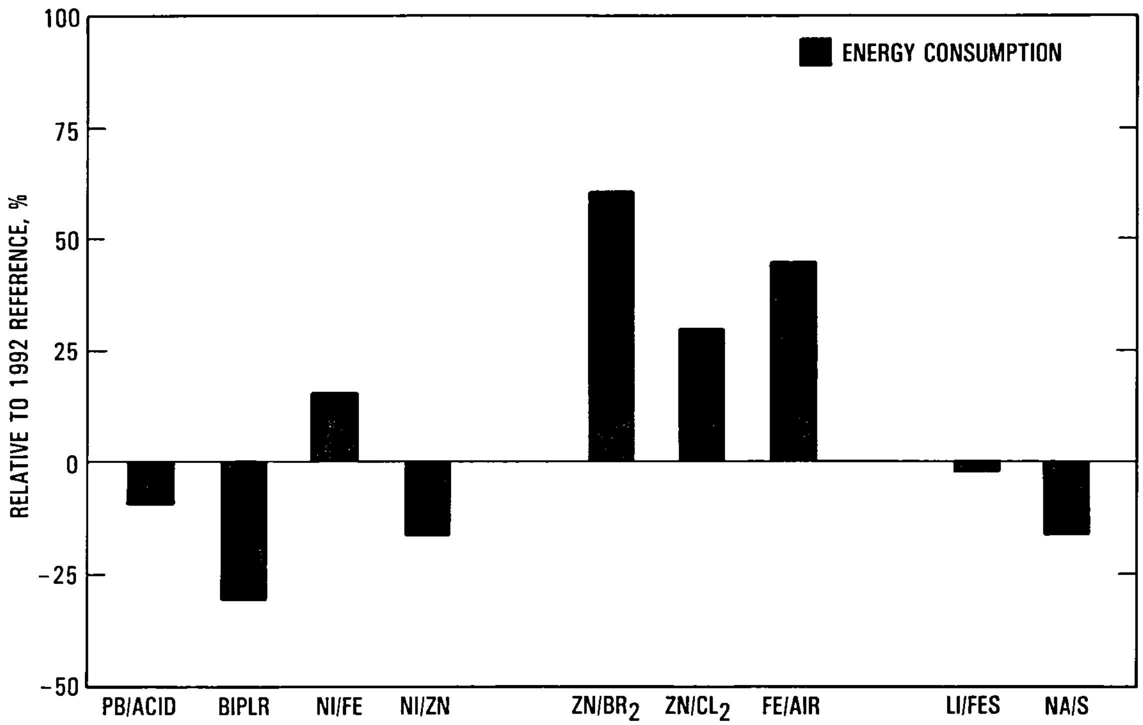


Figure 4-8. Five-Passenger 160-km Energy Comparison

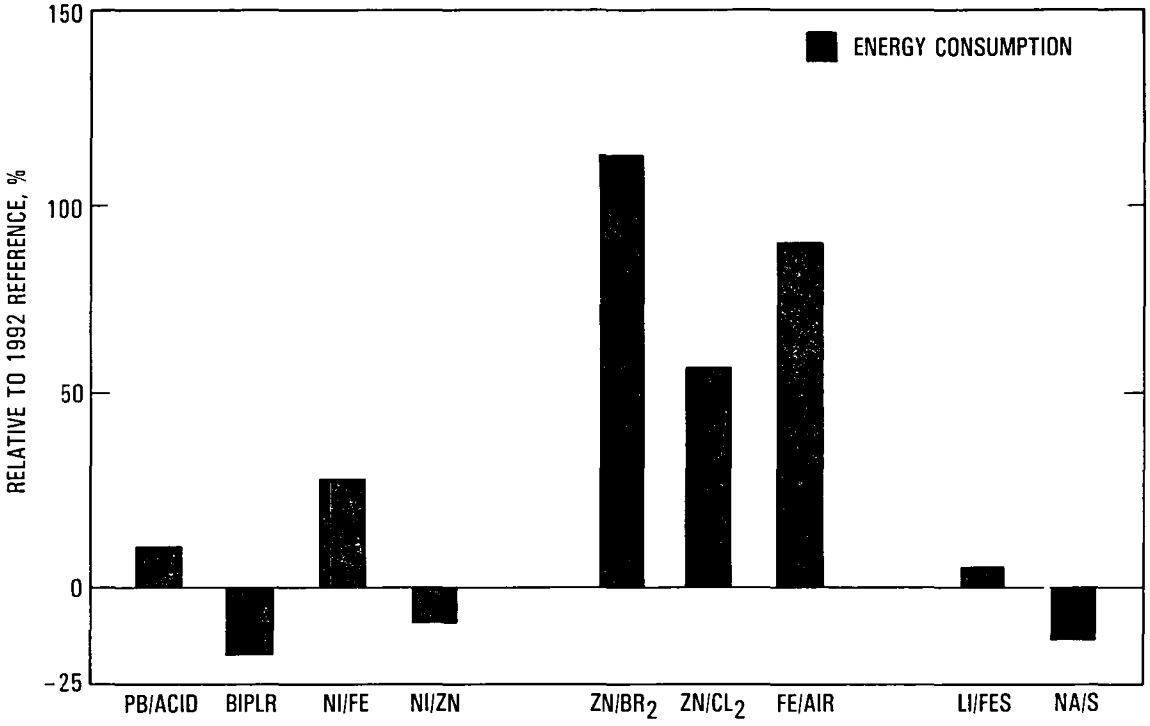


Figure 4-9. Five-Passenger 240-km Electrical Vehicle Energy Comparison

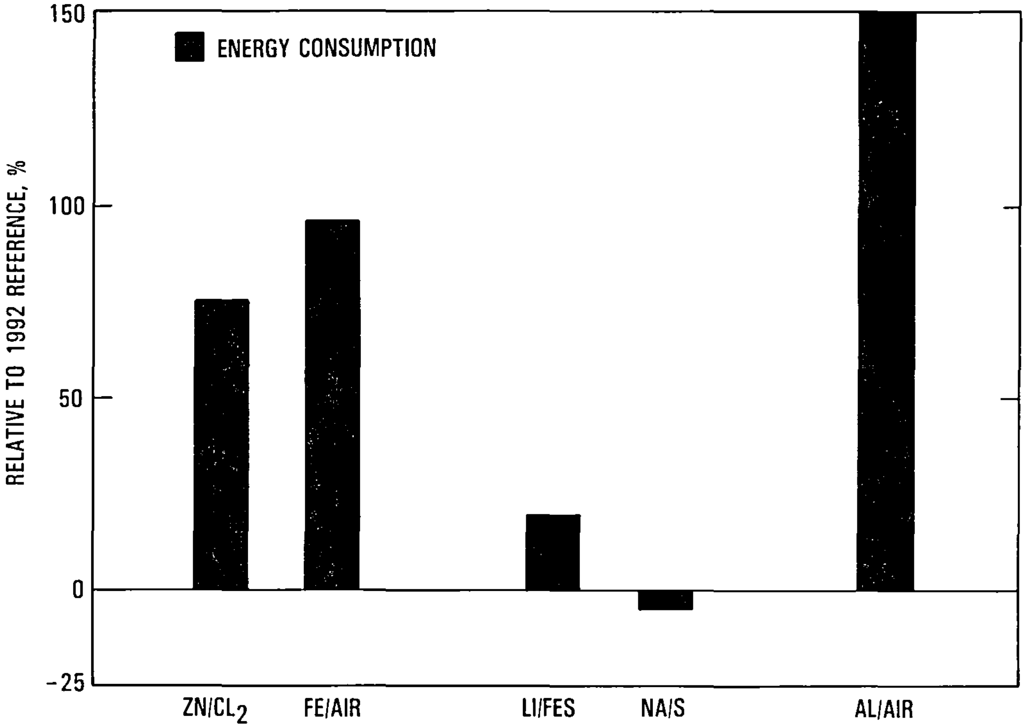


Figure 4-10. Five-Passenger 400-km Electric Vehicle Energy Comparison

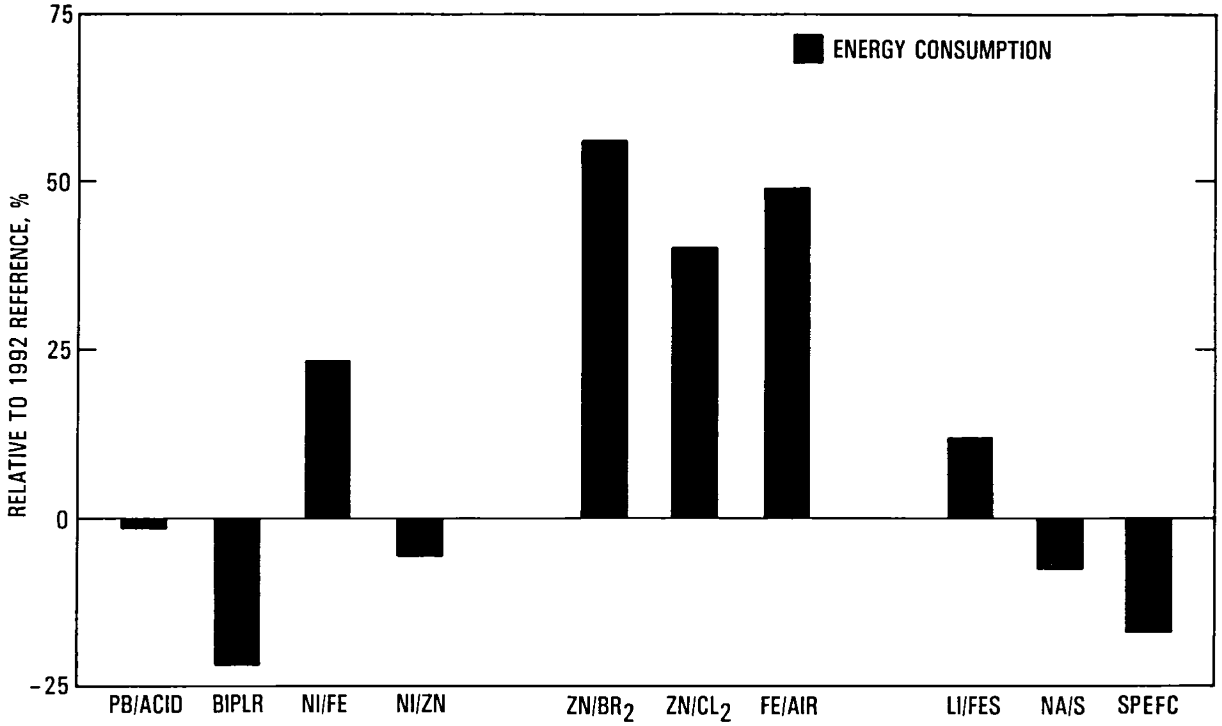


Figure 4-11. Five-Passenger Hybrid and Fuel-Cell Vehicle Energy Comparison

SECTION V

COST ANALYSES

Vehicles of the AV Assessment have been designed with the same performance capabilities; therefore, the remaining major discriminators between vehicle types are relative maintenance, safety, and cost. The importance of the first two of these is addressed in the Preference Analyses of Volume IV, and the cost is presented in this section. Initial cost, life-cycle cost, and the break-even fuel price (BEFP) are estimated for the vehicles, assuming mass production costs of the components (detailed in Volume II). The results are presented relative to the competition for each mission, that is, advanced internal combustion engine-powered vehicles operating on nonpetroleum liquid fuel (methanol). The results should be viewed in a relative sense even though the cost model produces absolute costs for each vehicle, hence the use of cost ratios throughout this section.

A. ICE REFERENCE VEHICLES

A separate discussion of the reference vehicles is presented because of their widespread use throughout this section and the necessity of understanding the formidable competition to alternate vehicles in the next decade. When oil shortages signaled the demise of inexpensive liquid fuel over a decade ago, the U.S. automobile industry began a steady improvement of their vehicles and engines. The improvements have been substantial, and in many ways internal combustion engine technology has improved more than electric and hybrid vehicle technology. Further improved vehicles will be available by the time reliable and economical electric vehicles could be in production. For example, Figure 5-1 contrasts the life-cycle costs of a typical 1982 full-size vehicle (Reference 5-1) and the projected 1992 full-size reference vehicle. There are several notable items in this comparison. The life-cycle cost is expected to decrease (in 1982$), and the percentage of cost attributed to fuel is projected to remain about the same despite the much higher fuel cost per unit energy (methanol has about 1/2 the energy per gallon of gasoline). This is primarily due to the projected fuel economy of 23-mpg methanol (equivalent to 42 mpg on gasoline) compared to 19-mpg gasoline of the 1982 vehicle. The combination of a more efficient engine (due to leaning and high compression with methanol fuel) and a lighter vehicle makes for significant competition. The two-passenger commuter vehicle and the small van are not comparable to any large-production vehicle in 1982, and no direct comparison could be made of the relative efficiency; however, Table 5-1 shows the projected characteristics. Note that the costs are presented for the five-passenger vehicle for three annual distances because the same vehicle is used as the reference for all five-passenger vehicles.

B. RELATIVE INITIAL COSTS

Electric vehicle propulsion systems are more expensive than their counterparts in conventional vehicles (with the same power capability) and make up a larger percentage of the initial cost. The base vehicles were assumed to be identical for a given application, except for the additional

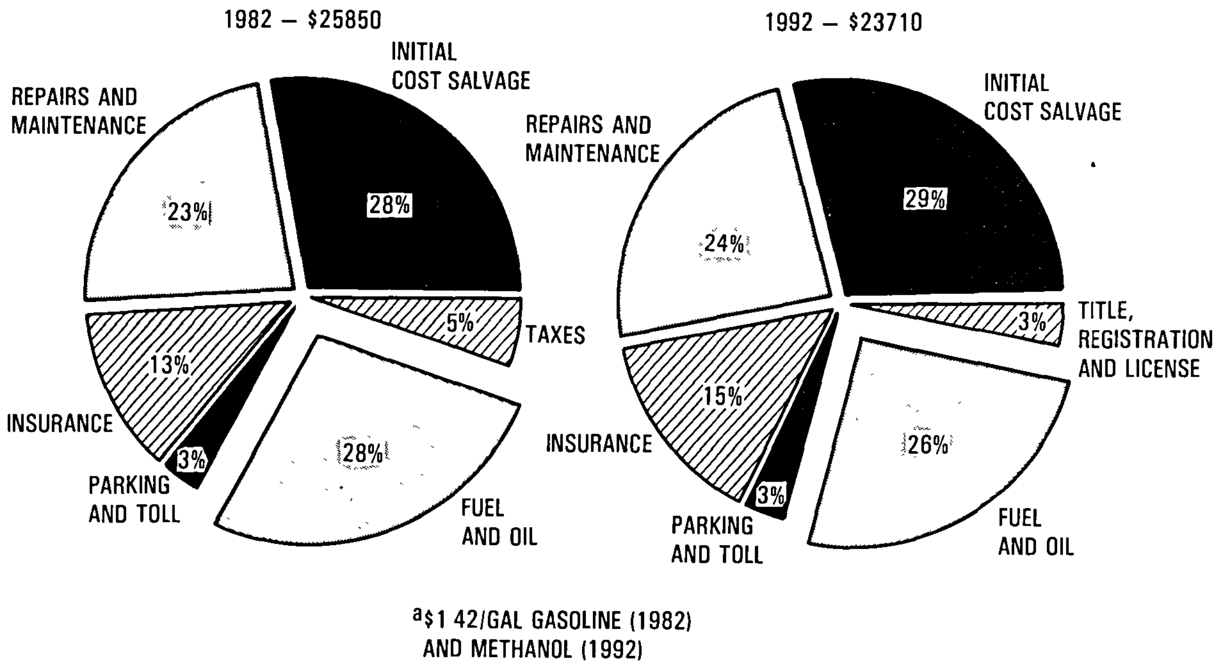


Figure 5-1. Comparison of 1982 and 1992 Full-Size Vehicles

Table 5-1. Reference Vehicle Characteristics

Reference vehicle	Curb weight, kg	Fuel economy methanol, mpg	Initial cost, 1982$	Life-cycle cost, 1982$
Two-passenger commuter				
11886 km/yr	500	31	4424	17035
Five-passenger general-purpose				
13237 km/yr	895	24	7210	21744
15011 km/yr				23087
16610 km/yr				23711
Commercial van				
12848 km/yr	1080	15	8500	25785

structural weight required for the heavier propulsion system. The additional cost due to the structural weight propagation is not negligible although the propulsion component costs account for most of the higher initial cost. This can be seen in the example bar graph of Figure 5-2, which shows the initial costs of the electric van propulsion components relative to the base vehicle. In many of the EVs the base vehicle costs almost as much as the reference van. However, the costing method for the base vehicle (i.e., $/kg) combines the structural weight with the rest of the base vehicle components, many of which are relatively expensive (i.e., glass, trim, etc.), and the weight propagation costs may be overestimated. At any rate, the costs are universally applied, and the relative merits of the vehicle candidates remain evident.

As presented in Section IV of this report, many of the vehicles have the potential to save energy (and/or displace liquid fuel) if they replaced conventional vehicles. The costs to realize this potential are substantial, as shown in the table of initial cost ratios (Table 5-2). The range of costs presented is the result of the variation in battery cost projections by the Review Board, which are detailed in the Subsystems Assessment, Volume II. Each of the vehicles is described in detail in the summary cost sheets contained in the appendices of this volume.

Note that the least expensive of the vehicles cost 50 to 100% more than the appropriate reference vehicle and the strong dependence of initial cost on electric range. This is due to the compound effects of increasing battery weight for more energy, increasing the power of the motor/controller due to the weight increase, and structural weight propagation. In fact, by the time the range of the electric vehicles is increased to 400 km to compete with

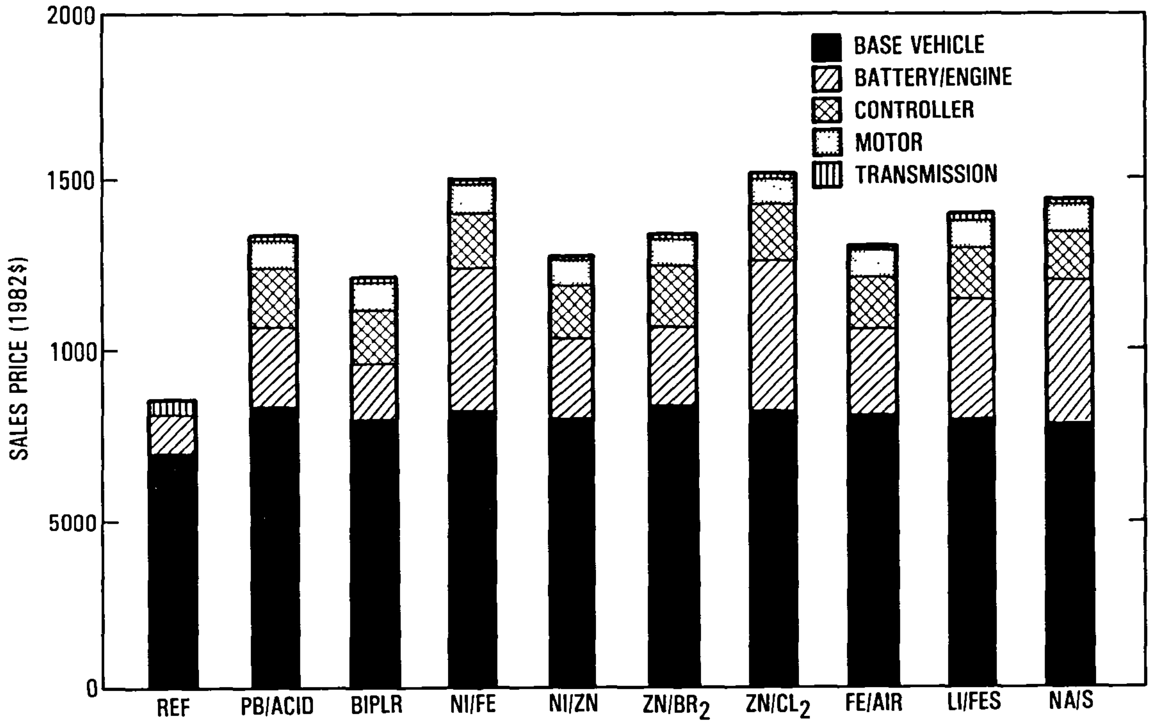


Figure 5-2. Initial Cost Components of Advanced Vans

Table 5-2. Advanced Vehicle Initial Cost Ratios[a]

Battery	Vehicle range, km: Van-96	2P-128	5P-160	5P-240	5P-400	HVs, FCVs-400
Pb/Acid	57-63	72-86	91-99	142-155	NA	106-114
BipPb/Acid	41-50	49-62	68-83	119-148	NA	76-84
Ni/Fe	77-82	93-104	105-112	147-157	NA	126-127
Ni/Zn	49-51	53-56	86-92	115-122	NA	90-93
Zn/Br_2	57-77	77-121	84-111	137-178	NA	110-137
Zn/Cl_2	78-80	108-111	107-110	172-176	174-198	139
Fe/Air	52-78	68-141	75-109	131-192	123-175	102-141
Li/FeS	62-70	75-79	85-95	111-125	168-201	115-116
Na/S	67-70	83-100	98-102	129-133	153-165	155-201
Al/Air	NA	NA	NA	NA	155-201	NA
SPE FC	NA	NA	NA	NA	NA	143

[a]Percent greater than reference vehicle.

full-performance conventional vehicles, the initial cost is 125 to 200% more than the reference vehicle. If initial cost is the primary concern, a better way to get full performance and substantial liquid-fuel displacement is with the hybrid vehicles although the initial cost premium may still be prohibitive. The least expensive of these is projected to cost 75 to 95% more than the reference vehicle.

C. RELATIVE LIFE-CYCLE COSTS

It is apparent from the previous discussion that advanced vehicles are not projected to compete on the basis of initial cost; however, in many cases they could be comparable in life-cycle cost. The reasons for this phenomena can be seen in the comparison of the life-cycle cost components of the electric vans and the reference vehicle (Figure 5-3). Only a third of the reference vehicle's costs are made up of the initial cost, with the remaining 67% in operating costs. The relative initial and operating costs essentially reverse for the electric vehicles, with the smaller operating costs due to lower maintenance and fuel costs. In fact, these lower costs often offset the higher initial costs in the van category, adding up to lower life-cycle

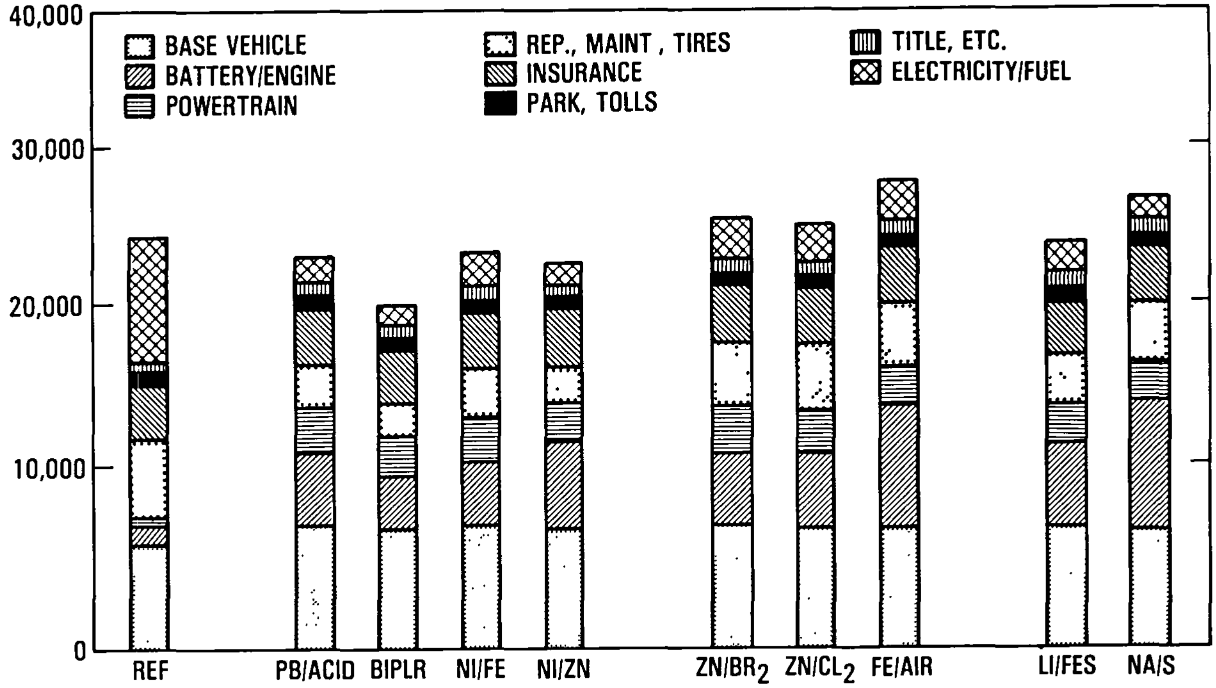


Figure 5-3. Life-Cycle Cost Components of Advanced Vans

costs. This is true in other applications as well, as shown in the table of relative life-cycle costs (Table 5-3). The relative costs are sensitive to the electricity and methanol costs, which were assumed to be $0.05/kWh and $1.42/gal, respectively (see Volume IV for more details).

Van and commuter vehicle applications are the most attractive for electric vehicles in this respect. Most of the vehicles could produce life-cycle costs equal to or less than the reference vehicle, while saving substantial amounts of energy. The best battery technologies for these applications are those with high power-to-energy designs that match the vehicle demands, which includes conventional and bipolar lead/acids, nickel batteries, and the bipolar design of lithium/iron sulfide. Even the electric vehicles with 160-km range are not discouraging with regard to life-cycle cost. The best of these could cost about 5% less than the reference and the worst about 25% more. As range increases, the electric vehicles are less appealing. None of the vehicles could boast of lower life-cycle cost at a range of 240 km, and the relative costs are 25 to 100% more at a 400-km range.

Full-performance applications are best left to the hybrid vehicles. Relative life-cycle costs are approximately equivalent to the 240-km electrics and lower than the 400-km electrics, with some exceptions. Another advantage of the hybrid vehicles over long-range electrics is that the P/E requirements of the battery are similar to those of the short-range vehicles, and radically different battery development is not necessary. In addition, these applications do not require extremely high-energy batteries (although it would be advantageous as long as the power capability was increased to match the P/E requirements of the application).

Table 5-3. Advanced Vehicle Life-Cycle Cost Ratios[a]

Battery	Vehicle range, km					
	Van-96	2P-128	5P-160	5P-240	5P-400	HVs, FCVs-400
Pb/Acid	(3-5)	(4-6)	7-8	19	NA	26
BipPb/Acid	(16-17)	(16-18)	(4-6)	5-14	NA	9-10
Ni/Fe	(2-4)	(1)-2	11-14	23-26	NA	26
Ni/Zn	(6-7)	(9-10)	9-10	10-11	NA	21
Zn/Br_2	4-10	8-14	19-23	36-39	NA	40-42
Zn/Cl_2	2-3	10-11	19-20	40-41	40-48	29
Fe/Air	13-20	13-14	22-25	40-50	25-40	51-55
Li/FeS	(2-3)	(4)	5	10-14	27-38	29
Na/S	9-10	7-9	16-17	15	25-29	38
Al/Air	NA	NA	NA	NA	96-111	NA
SPE FC	NA	NA	NA	NA	NA	30

[a]Percentage greater or less than ( ) reference.

D. BREAK-EVEN FUEL PRICES

Relative life-cycle costs are sensitive to the assumed fuel costs. With the uncertainty concerning the price of fuel in the future, perhaps the most pertinent question is: What fuel price is necessary for the alternative vehicles to become competitive on a life-cycle cost basis? The purpose of the break-even fuel price is to give some measure of the relative economics of the candidate systems without having to use a crystal ball to predict future liquid-fuel prices.

Break-even fuel prices are calculated by setting the life-cycle costs of the candidate vehicles equal to that of the reference vehicle with fuel price as a variable. The solution implies that the BEFP equals the difference in life-cycle costs (without fuel costs) divided by the difference in fuel used (i.e., fuel saved by the candidate vehicle). Hence, higher fuel savings or lower differences in costs produce lower BEFPs; and this parameter provides an economic indicator containing relative fuel efficiency.

Table 5-4 compares the BEFPs of the AVs with the projected methanol price in the early to mid 1990s. Those vehicles with projections of lower life-cycle costs than the reference vehicle (see Table 5-3) would be competitive at fuel prices lower than the projected value of $1.42/gal. These are highlighted in Table 5-4 with negative percentages (in parentheses).

Table 5-4. Advanced Vehicle Break-even Fuel Price Ratios[a]

	Vehicle range, km					
Battery	Van-96	2P-128	5P-160	5P-240	5P-400	HVs, FCVs-400
Pb/Acid	(9-15)	(18-26)	35-40	79-80	NA	146-147
BipPb/Acid	(52-54)	(78-87)	(14-23)	22-60	NA	48-55
Ni/Fe	(2-12)	(3)-11	53-64	95-108	NA	144-145
Ni/Zn	(17-19)	(44-48)	43-48	45-47	NA	112-115
Zn/Br_2	15-36	43-70	85-105	148-162	NA	231-243
Zn/Cl_2	9-12	55-59	87-92	165-170	158-189	205
Fe/Air	46-71	66-73	101-112	166-207	102-167	286-309
Li/FeS	(4-8)	(17-18)	24-26	43-61	109-150	161-162
Na/S	32-34	39-50	74-76	62	101-115	203-204
Al/Air	NA	NA	NA	NA	380-439	NA
SPE FC	NA	NA	NA	NA	NA	770

[a]Percentage greater or less than ( ) reference.

E. SUMMARY OF RELATIVE ECONOMICS

1. Electric Vans

Electric vans in applications requiring limited daily range seem to be an economical alternative to methanol-fueled vehicles. However, the relative economics are dependent on the availability (and hence the cost) of liquid fuel. Most of the battery candidates could lead to competitive vehicles on a life-cycle basis, but the initial costs are projected to be 40 to 75% more than the competition. At any rate, the most promising vehicles are those powered by batteries with appropriate P/E ratios and the potential for low-cost operation. The most economical candidates are the bipolar Pb/Acid and Ni/Zn, with performance of 160 to 180 W/kg at low states of charge and 50 to 60 Wh/kg on the van cycle (P/E = 3). Figure 5-4 summarizes relative costs and BEFPs, assuming the low battery costs of the Review Board estimates.

2. Two-Passenger Electric Commuter Vehicles

The relative economics of the commuter vehicle candidates are almost identical to those of the vans because of similar P/E requirements. The same batteries are attractive although the relative initial and life-cycle costs are slightly higher than the van case. Again, the bipolar Pb/Acid and Ni/Zn seem to be the most promising, as shown in Figure 5-5.

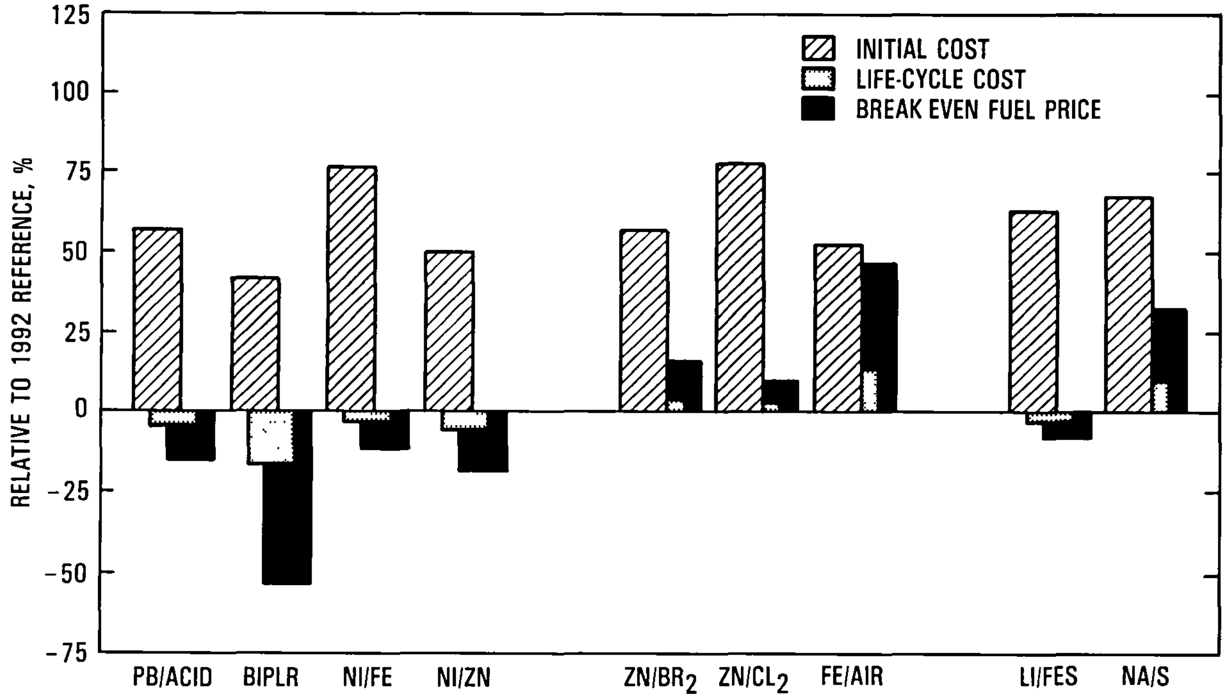


Figure 5-4. Electric Van Relative Economics (Low Battery Cost)

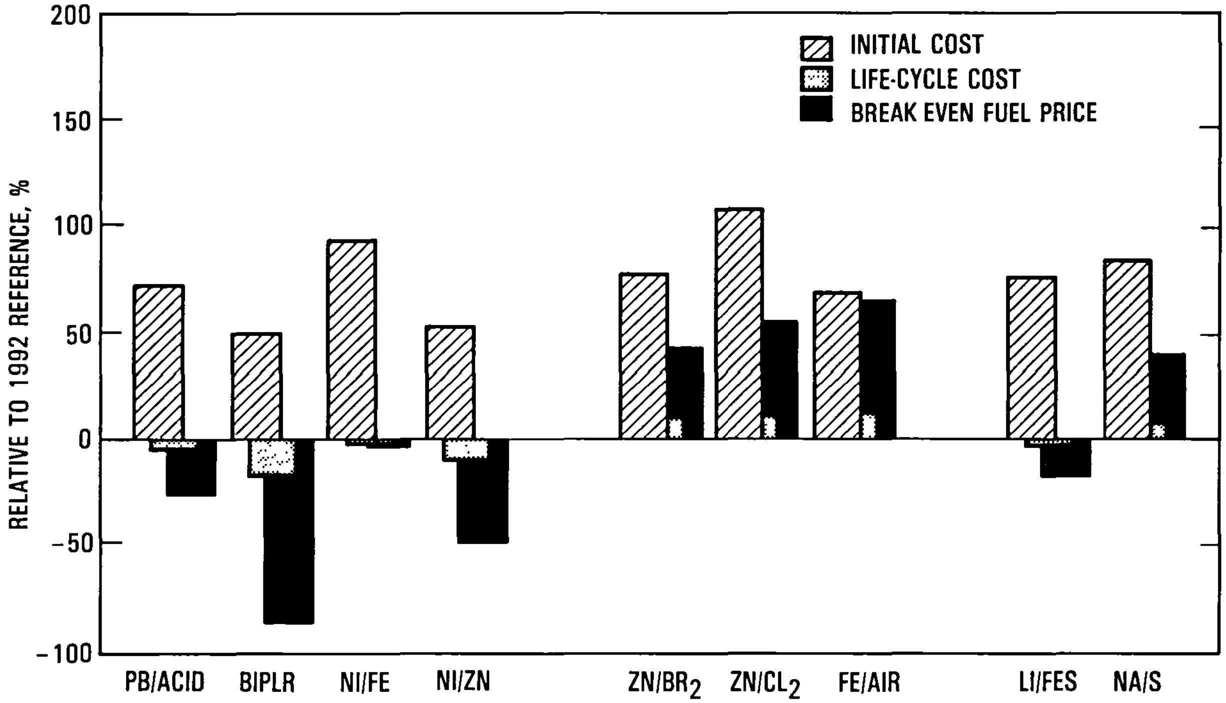


Figure 5-5. Two-Passenger 128-km EV Relative Economics (Low Battery Cost)

3. Five-Passenger General-Purpose Electric Vehicles

The most attractive range of those investigated is 160 km for five-passenger vehicles although the initial cost differential of 60 to 100% above the reference may be prohibitive. The bipolar Pb/Acid, Ni/Zn, and Li/FeS have the lowest initial costs and are reasonably close to the reference vehicle with regard to life-cycle cost. Results for the 240-km vehicles are similar, but the costs of the 400-km vehicles are not likely to be attractive unless liquid fuel is unavailable. Figures 5-6 through 5-8 contrast the results for the three ranges.

4. Five-Passenger Hybrid and Fuel-Cell Vehicles

Initial cost premiums of the hybrid and fuel-cell vehicles are comparable to the mid-range electric vehicles, but life-cycle costs for the most economical candidates are within 10 to 20% of the reference. Fuel savings are in the 70 to 75% range for the HVs, hence the vehicles may be desirable if liquid fuel is restricted. The most promising candidates are similar to those for the short electric-range applications (i.e., vans, commuters) because of the battery performance requirements. The fuel-cell vehicle saves only 20% of the fuel compared to the reference, and the economics are not more attractive than the HVs (Figure 5-9).

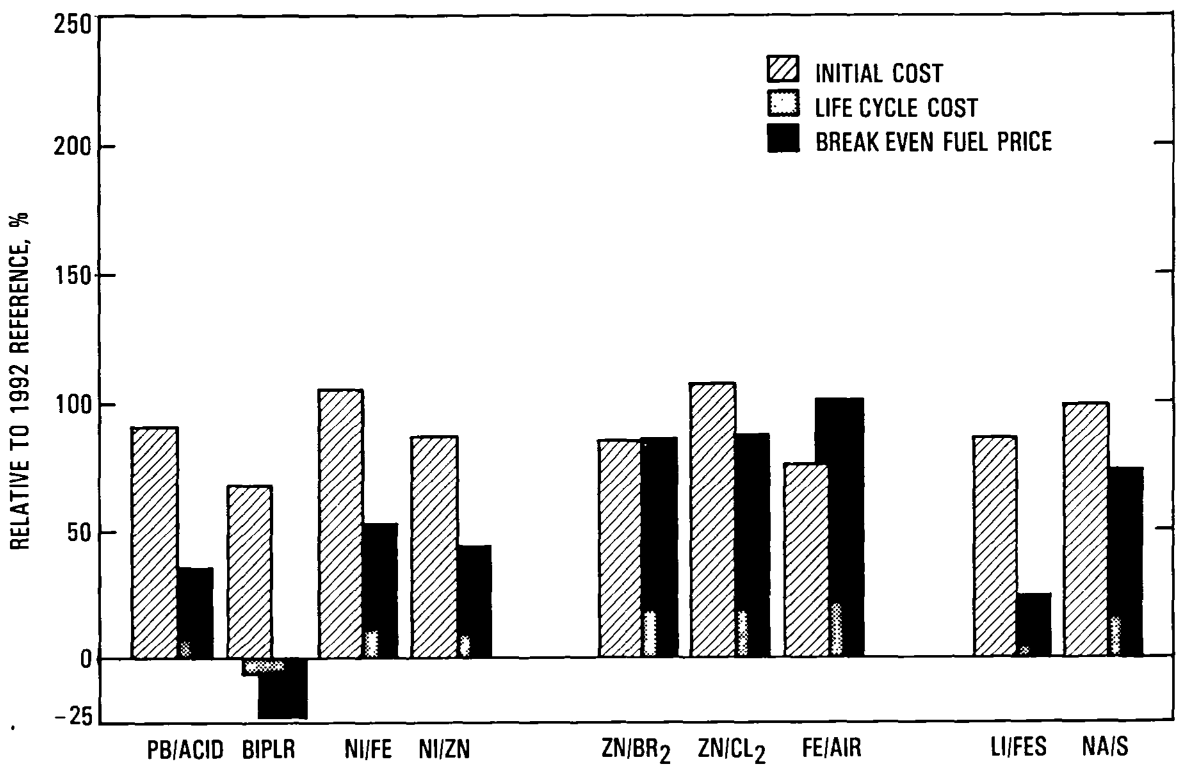


Figure 5-6. Five-Passenger 160-km EV Relative Economics (Low Battery Cost)

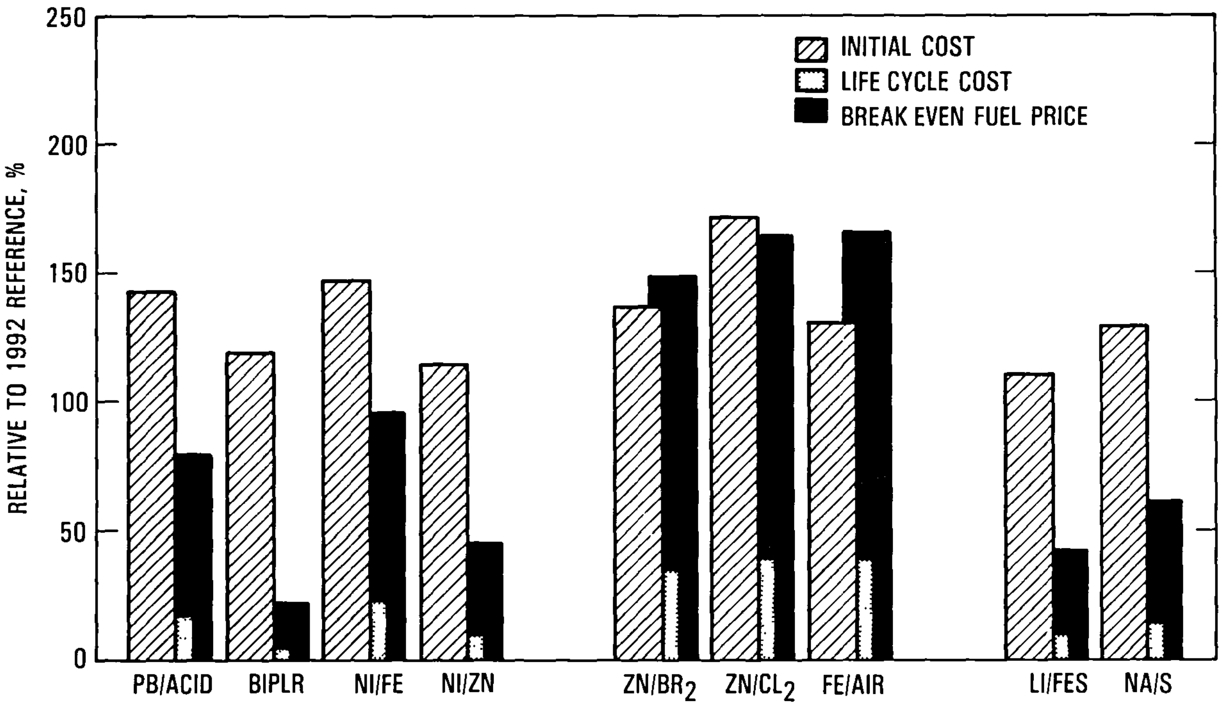


Figure 5-7. Five-Passenger 240-km EV Relative Economics (Low Battery Cost)

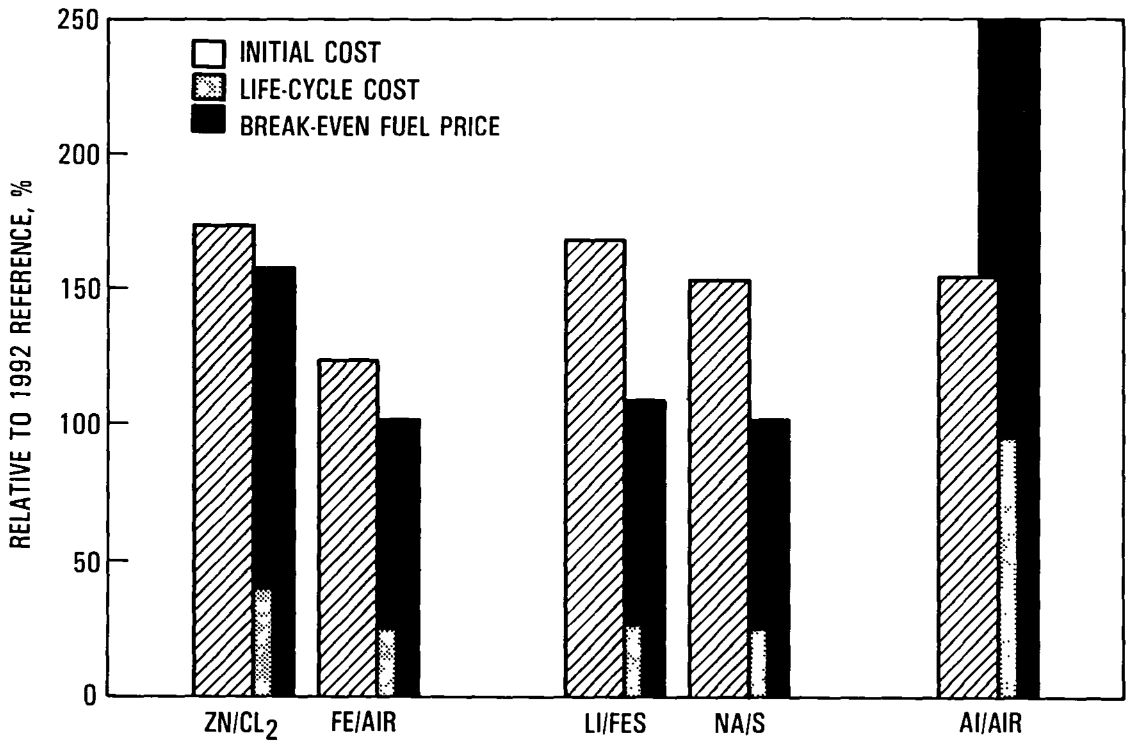


Figure 5-8. Five-Passenger 400-km EV Relative Economics (Low Battery Cost)

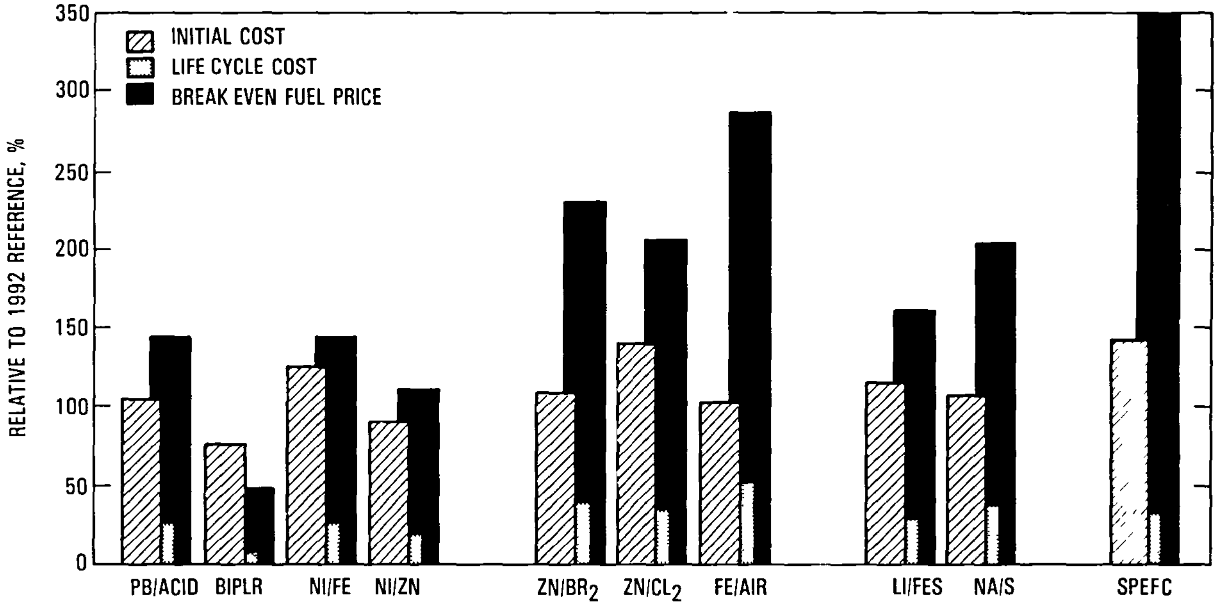


Figure 5-9. Five-Passenger HV and FCV Relative Economics (Low Battery Cost)

SECTION VI

SENSITIVITY ANALYSES

This section deals with the uncertainty surrounding some of the basic assumptions of this assessment. Perhaps the most influential assumptions are the battery performance and cost projections by the review board. Vehicle design and simulation results based on the battery developers' projections are presented in this section. The electric range of HVs with an "either/or" control strategy is addressed with designs and analyses of vehicles with ranges of 48 to 112 km. This report leans heavily toward the battery subsystem as being the prime discriminator between systems; however, cost reduction of the other unique subsystem to EHVs, the motor/controller, can lighten the burden for batteries. Hence, the impact of a 50% powertrain cost reduction is addressed. The impact of warm-up fuel consumption and load-leveling fuel-cell on vehicle economics is presented as well.

A. VEHICLES BASED ON THE BATTERY DEVELOPER PROJECTIONS

Subcontracts were provided to several battery developers to address the design flexibility of their batteries as well as the dependence on design of the other primary characteristics of life, volume, cost, etc. according to a "Guideline for Contractor Response" (contained in Volume V, along with the contractors' reports). The contractors were asked to provide specific designs targeting P/E ratios of 1.0, 2.1, 2.4, and 3.3, corresponding approximately to the requirements of the 400-km EVs, two-passenger commuters, vans, and hybrids, respectively. The information was used to edit the component sizing program, AVSIZING, to form a new version called AVDESIGN and a new bulk data file for ELVEC (BULKR.DAT). The vehicle design and simulation process was repeated and a new version of AVCOST (AVCOSTR) was used to estimate the initial and life-cycle costs. The results of the design process and economic analyses are shown on the following pages in tables of vehicle characteristics and bar charts of relative energy consumption and economics (Tables 6-1 through 6-8 and Figures 6-1 through 6-12). Packaging studies were not necessary because the projections were more optimistic than those of the review board. Graphs of the developers' battery discharge curves and power versus state-of-charge information are contrasted to the board's projections in the appendices of this volume, as are the resulting vehicle cost sheets.

The subcontractors in this effort were Eagle-Picher Industries, Inc. (Ni/Fe); Energy Development Associates (Zn/Cl_2); Westinghouse Electric Corporation (Fe/Air); Argonne National Laboratory and Gould Defense Systems, Inc. (Li/FeS); Ford Aerospace and Communications Corporation (Na/S); and Lawrence Livermore National Laboratory (Al/Air). Other batteries are shown for comparison purposes: Pb/Acid costing $80/kWh (U.S. Department of Energy sales price goal); bipolar Pb/Acid efficiency of 85% for reference; Ni/Zn costing $200/kWh (Delco-Remy price estimate); and Zn/Br_2 costing $28/kWh-OEM (for the Exxon estimate, see the Symons report in Volume V).

It is apparent from the figures that the developers were more optimistic than the review board; however, the projections are not necessarily consistent in terms of the level of optimism (i.e., technical feasibility), and the cost

Table 6-1. Van Designs Based on Battery Developers' Projections

Battery	Curb weight, kg	Battery weight, kg	DOD[a] at range, %	Wall-plug elec., Wh/km[b]
Ni/Fe	1588	348	81	379
Zn/Cl_2	1477	270	75	528
Fe/Air	1282	131	90	372
Li/FeS	1464	260	64	403
Na/S	1353	181	91	323

[a]Depth of discharge.
[b]Van cycle.

Table 6-2. Two-Passenger Commuter Vehicle Designs Based on Battery Developers' Projections

Battery	Curb weight, kg	Battery weight, kg	DOD at range, %	Wall-plug elec., Wh/km[a]
Ni/Fe	828	231	86	198
Zn/Cl_2	764	189	84	273
Fe/Air	616	81	91	187
Li/FeS	733	164	71	206
Na/S	658	111	91	164

[a]Federal Urban Driving Schedule.

Table 6-3. Five-Passenger 160-km Vehicle Designs Based on Battery Developers' Projections

Battery	Curb weight, kg	Battery weight, kg	DOD at range, %	Wall-plug elec., Wh/km[a]
Ni/Fe	1507	411	89	316
Zn/Cl_2	1378	322	92	433
Fe/Air	1153	168	93	300
Li/FeS	1338	295	75	325
Na/S	1226	218	93	258

[a]FUDS.

Table 6-4. Five-Passenger 240-km Vehicle Designs Based on Battery Developers' Projections

Battery	Curb weight, kg	Battery weight, kg	DOD[a] at range, %	Wall-plug elec., Wh/km[b]
Ni/Fe	1853	648	92	370
Zn/Cl_2	1717	555	94	520
Fe/Air	1266	245	95	329
Li/FeS	1507	311	85	355
Na/S	1418	350	95	287

[a]Depth of discharge.
[b]Federal Urban Driving Schedule.

Table 6-5. Five-Passenger 400-km Vehicle Designs Based on Battery Developers' Projections

Battery	Curb weight, kg	Battery weight, kg	DOD at range, %	Wall-plug elec., Wh/km[a]
Zn/Cl_2	1763	587	92	532
Fe/Air	1338	295	93	348
Li/FeS	1526	424	91	358
Na/S	1470	385	93	295
Al/Air	1507	411	99	NA[b]

[a]FUDS.
[b]Not applicable.

Table 6-6. Five-Passenger Hybrid Vehicle Designs Based on Battery Developers' Projections

Battery	Curb weight, kg	Battery weight, kg	DOD at range, %	Wall-plug elec., Wh/km[a]
Ni/Fe	1529	280	79	323/19
Zn/Cl_2	1517	273	86	468/19
Fe/Air	1257	117	90	314/22
Li/FeS	1368	184	53	335/21
Na/S	1327	159	90	277/21

[a]Electrical energy on FUDS, average methanol mpg beyond 80 km.

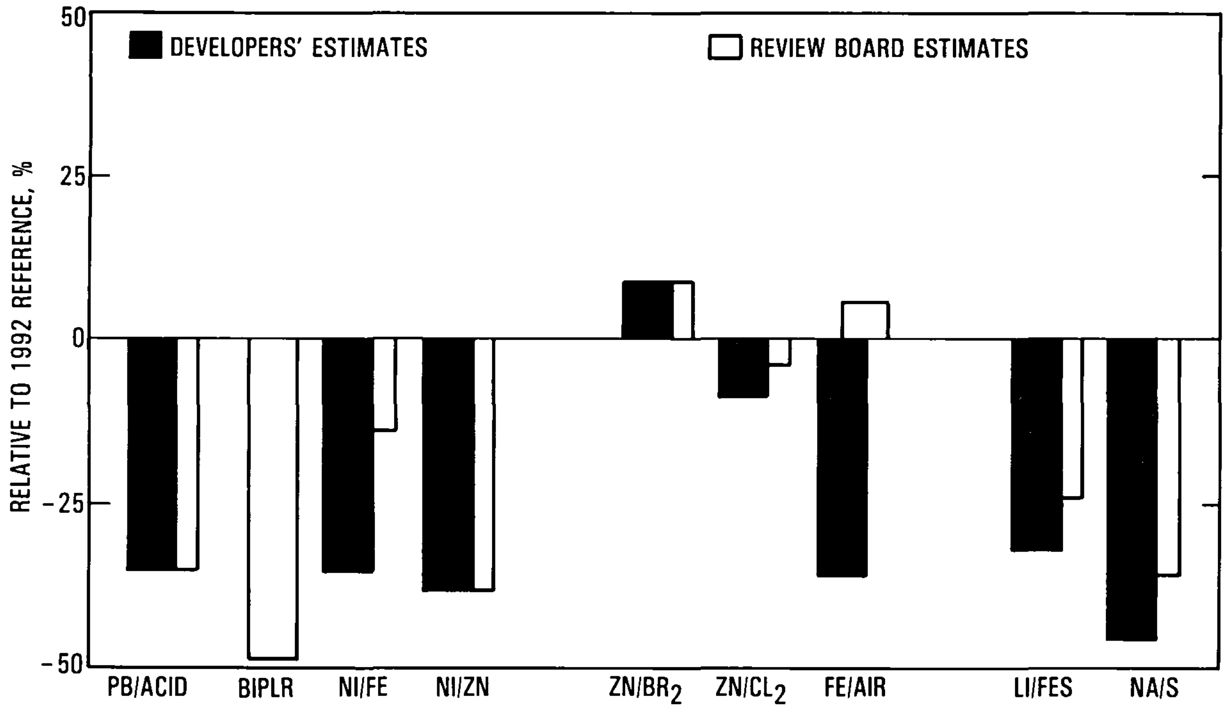


Figure 6-1. Relative Energy Consumption: Vans

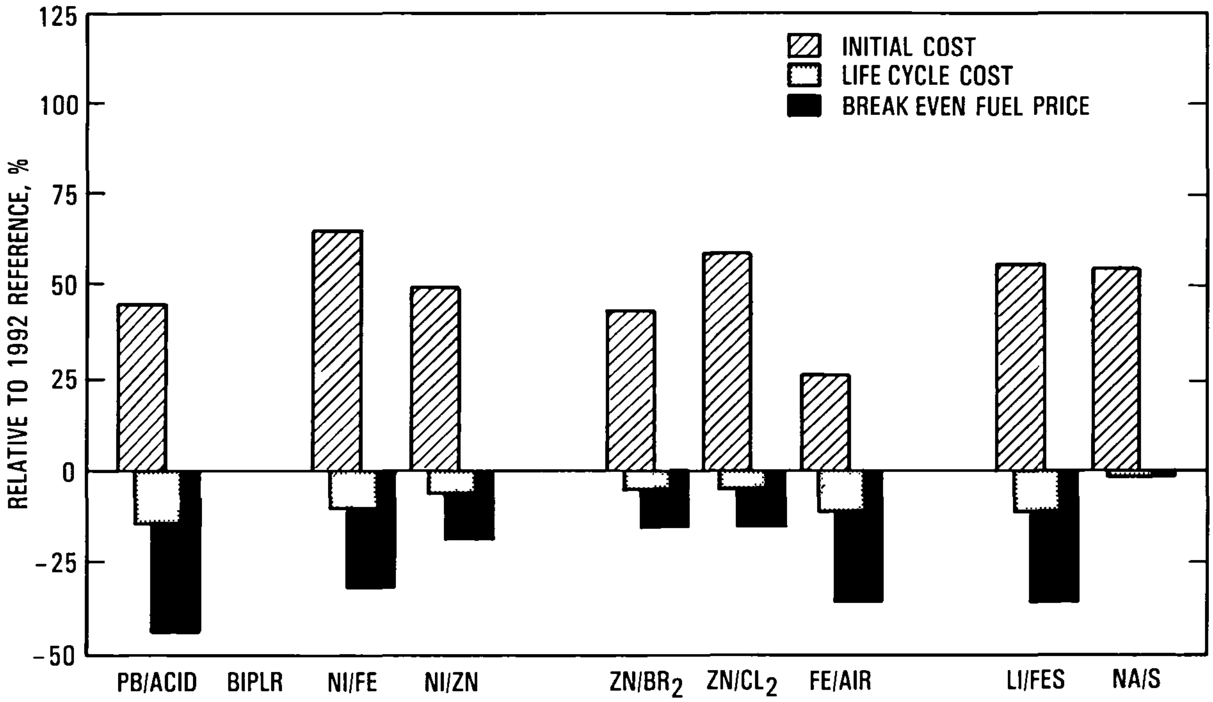


Figure 6-2. Van Economics: Developers' Estimates

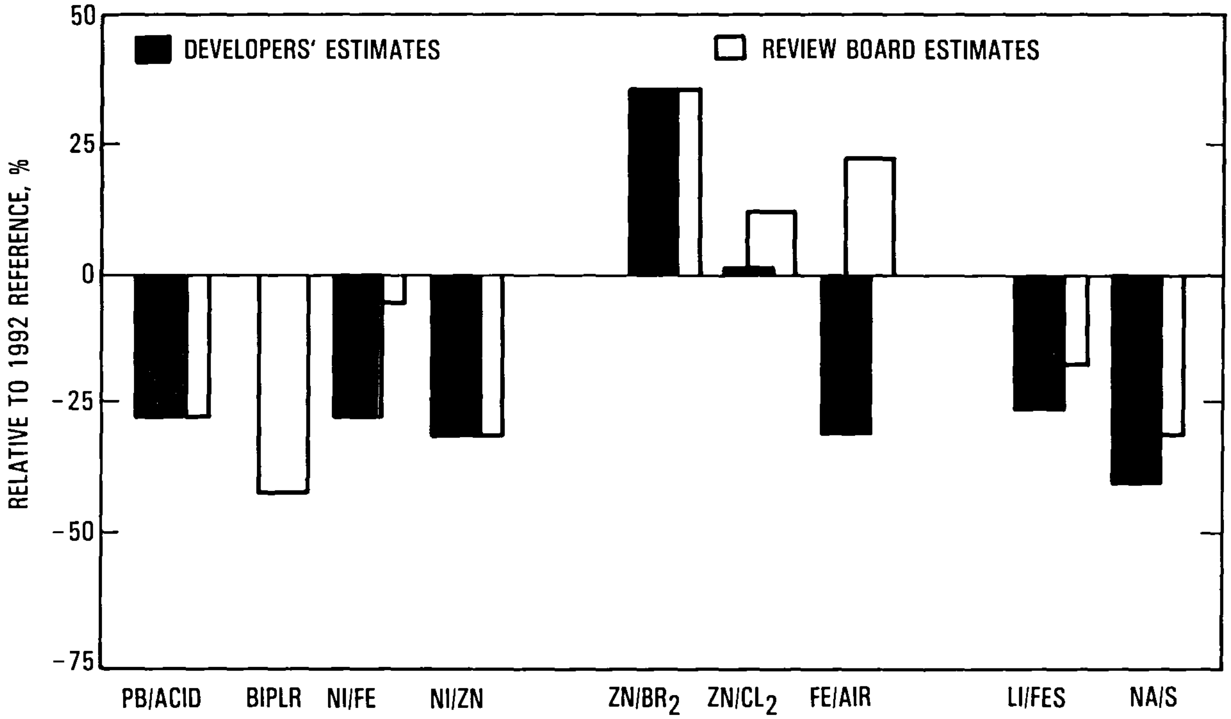


Figure 6-3. Relative Energy Consumption: Two-Passenger EVs

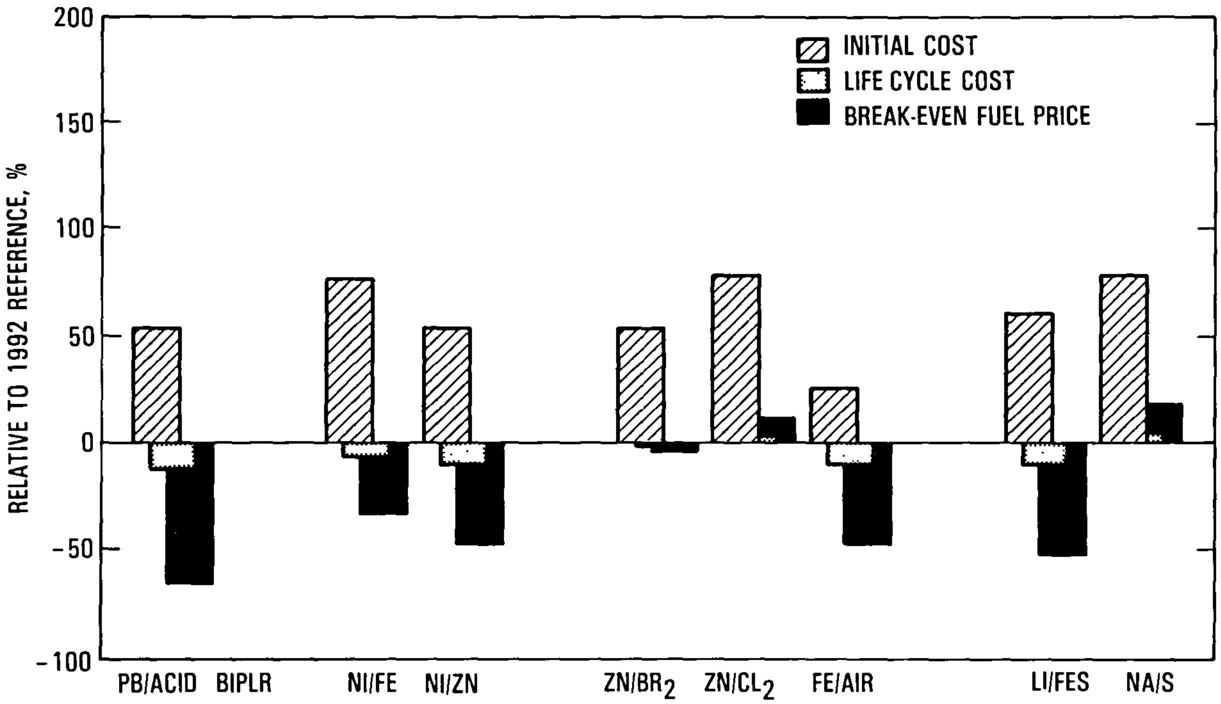


Figure 6-4. Two-Passenger EV Economics: Developers' Estimates

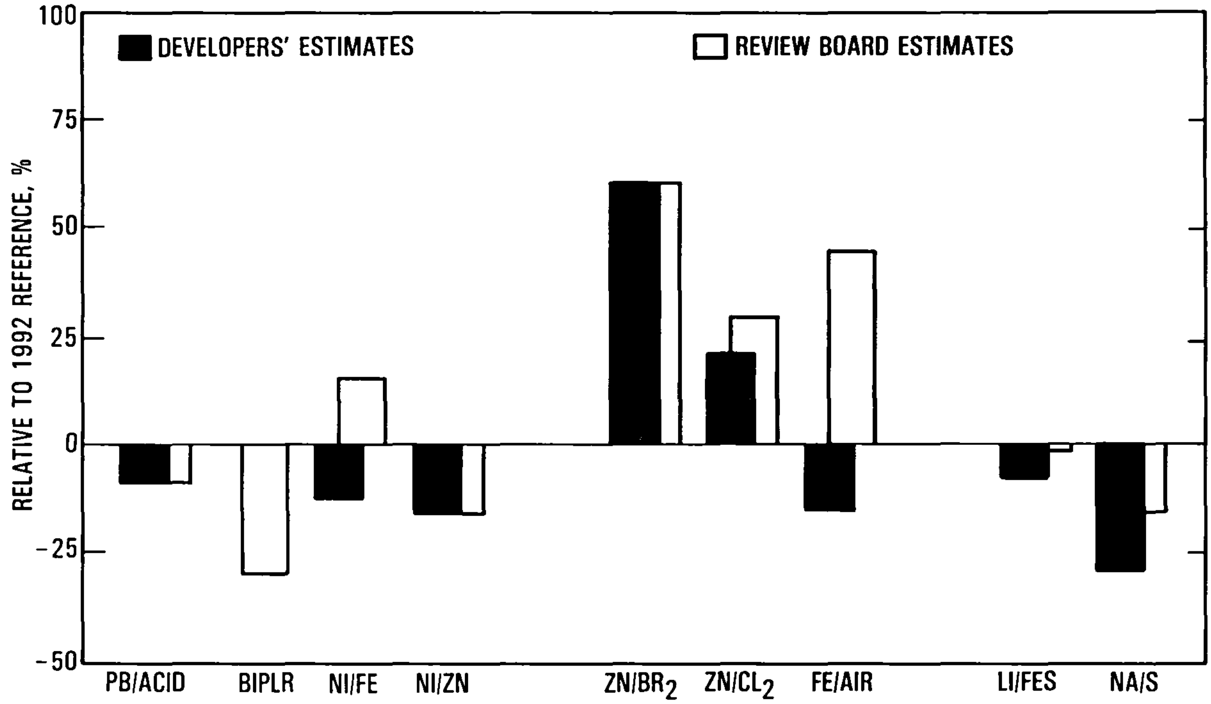


Figure 6-5. Relative Energy Consumption: Five-Passenger 160-km EVs

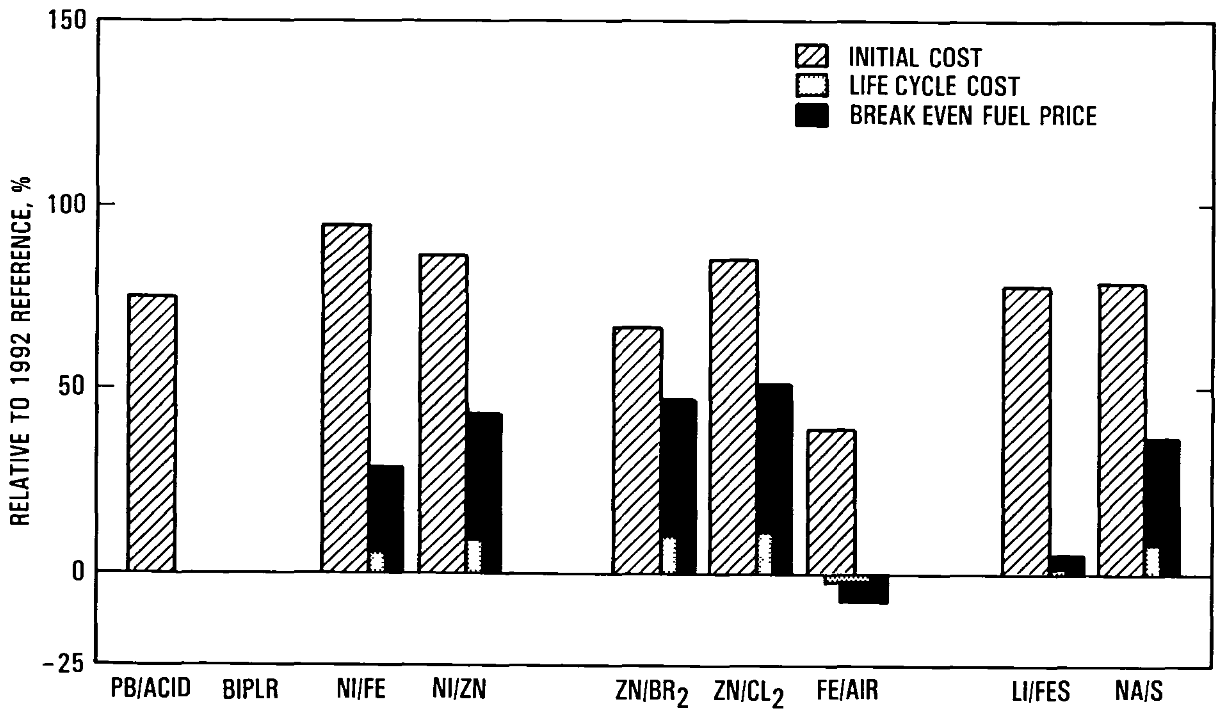


Figure 6-6. Five-Passenger 160-km EV Economics: Developers' Estimates

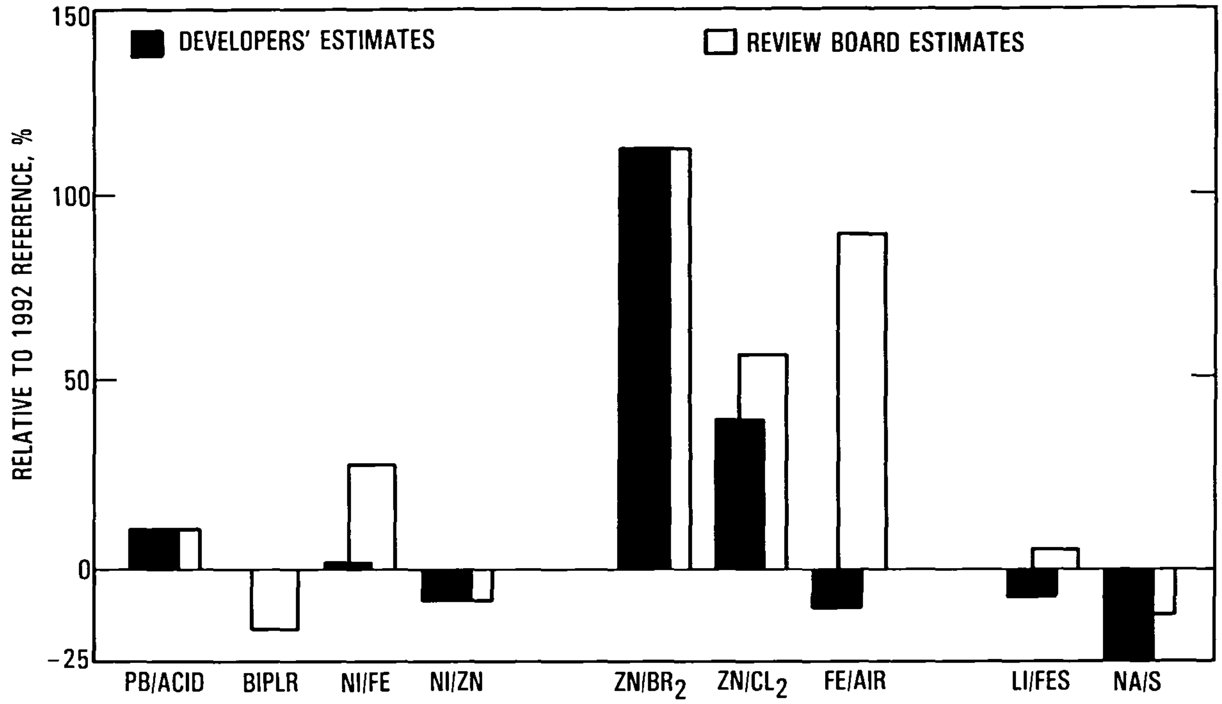


Figure 6-7. Relative Energy Consumption: Five-Passenger 240-km EVs

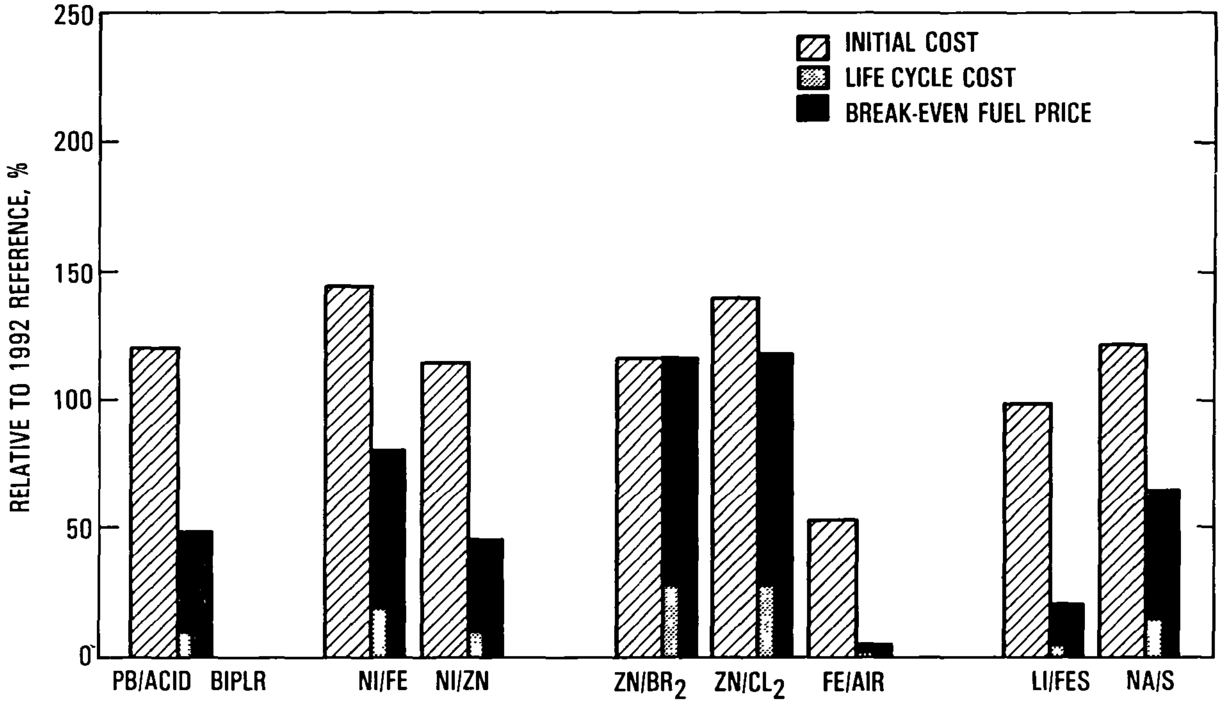


Figure 6-8. Five-Passenger 240-km EV Economics: Developers' Estimates

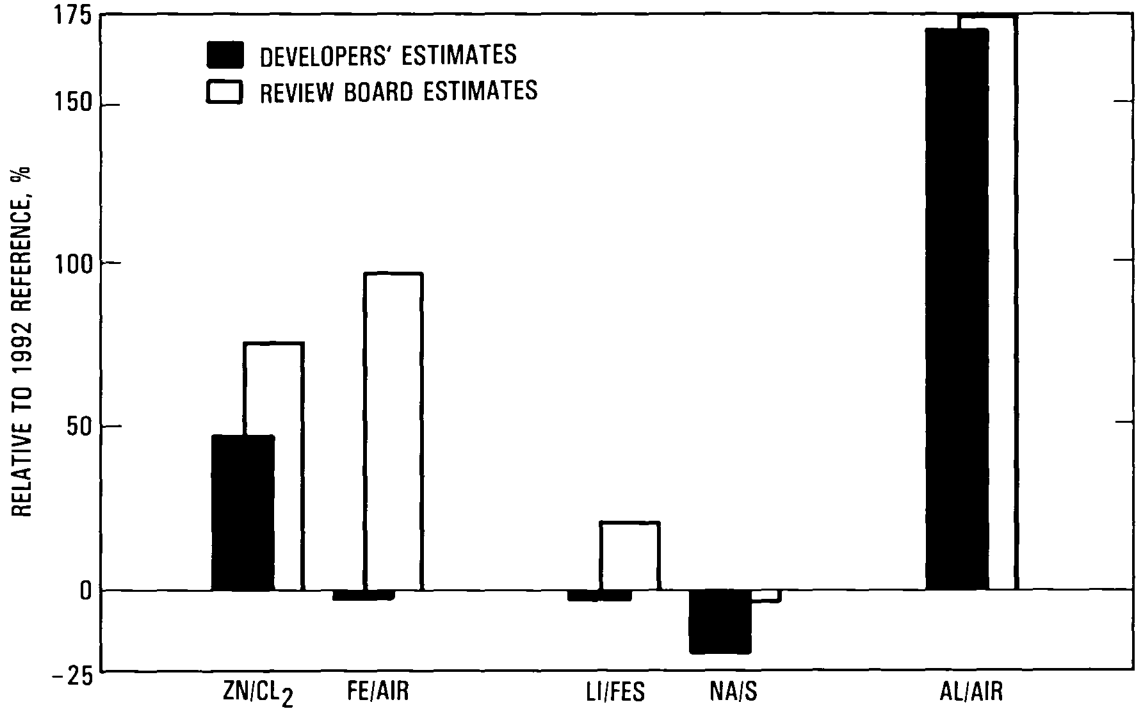


Figure 6-9. Relative Energy Consumption: Five-Passenger 400-km EVs

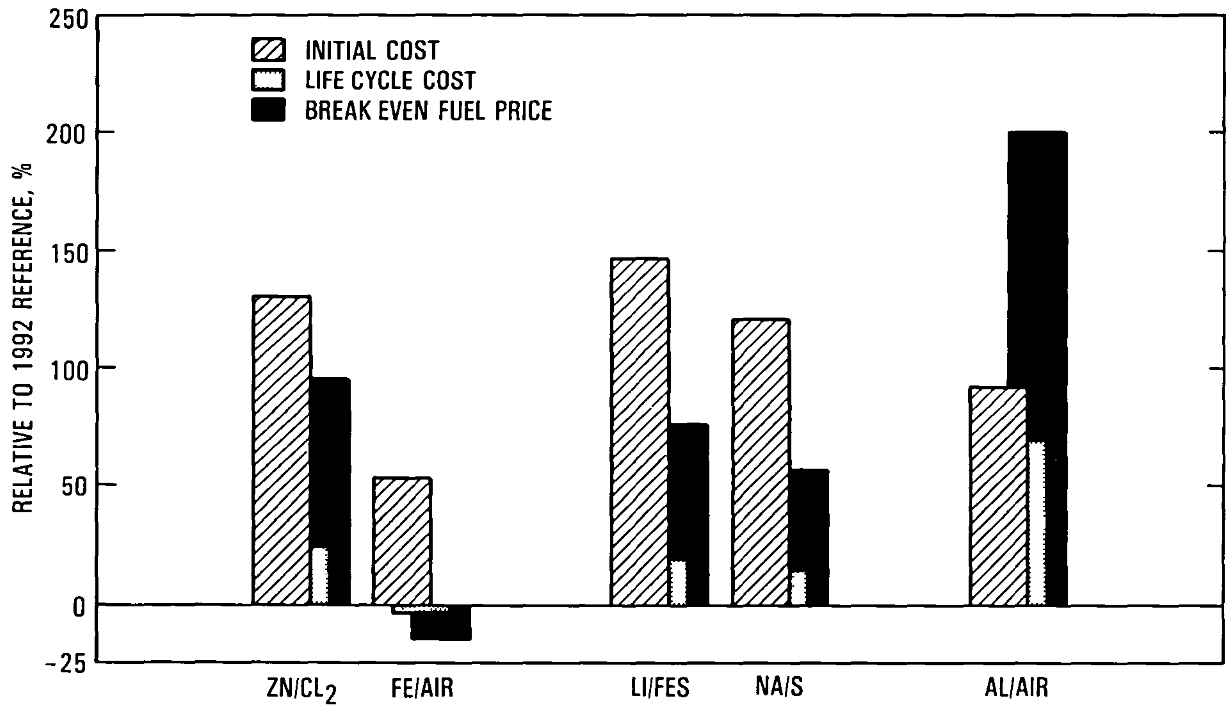


Figure 6-10. Five-Passenger 400-km Economics: Developers' Estimates

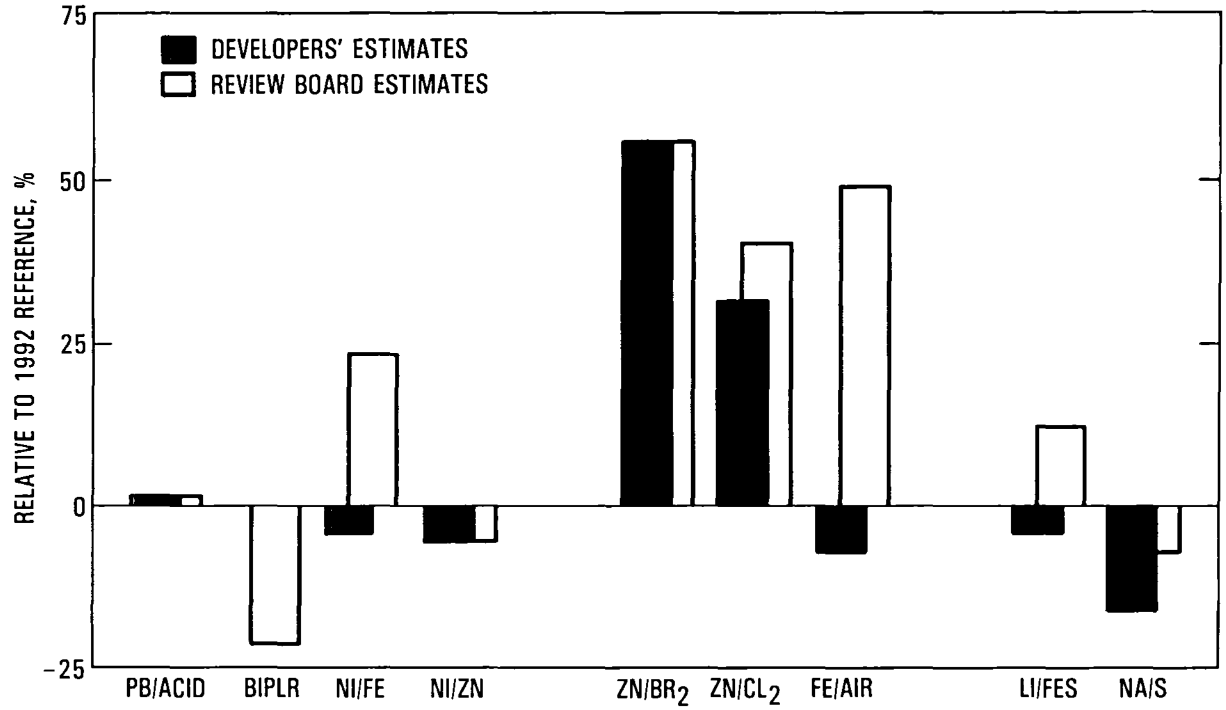


Figure 6-11. Relative Energy Consumption: Five-Passenger HVs

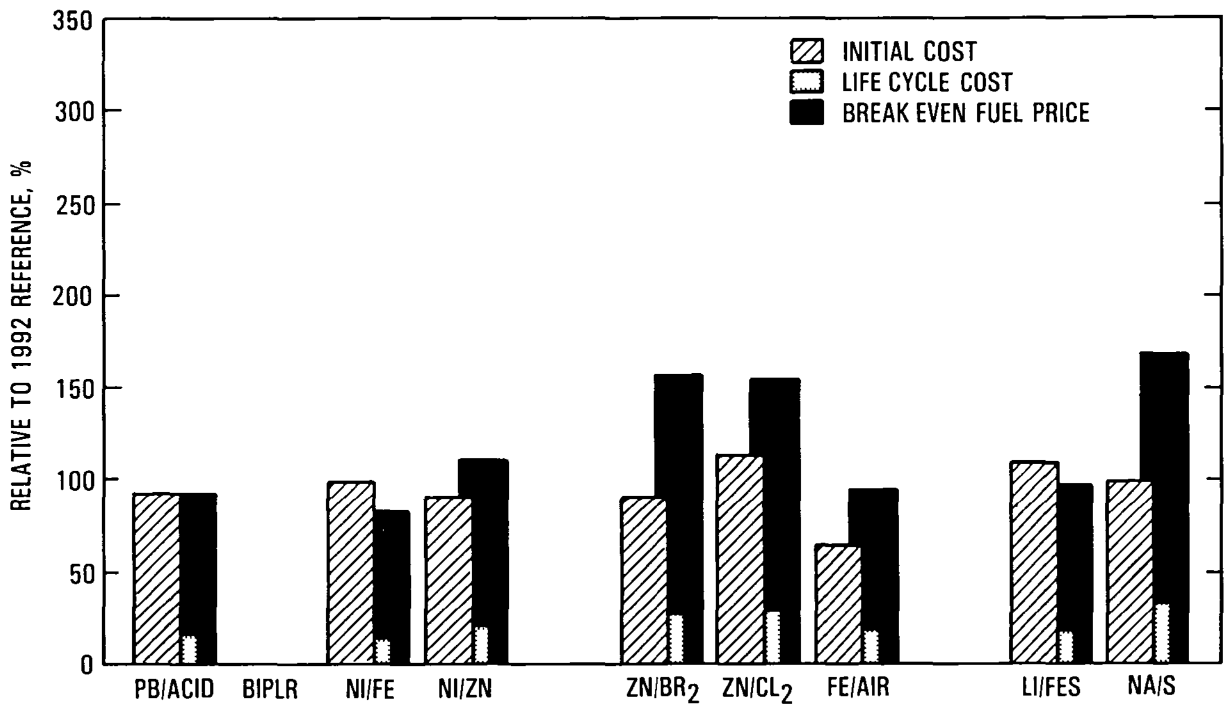


Figure 6-12. Five-Passenger HV Economics: Developers' Estimates

estimates should be viewed relative to the reference vehicle or the comparable design based on the review board projections. Direct comparison of vehicles shown on the bar graphs could produce considerable error in any type of ranking, and it is not encouraged.

There are several points that can be made, based on these analyses. If the projections of the developers are realized, all the batteries will be competitive in terms of life-cycle cost for the van and commuter vehicle applications. In fact, some of the candidates are attractive even in the long electric-range applications. It is also interesting to note that the relative attractiveness of the systems (i.e., vans versus 240-km EVs) remains the same, despite the differences between the review board's and developers' estimates. The challenge is to provide evidence that the projected performance can be attained.

B. EFFECTS OF DIFFERENT ELECTRIC RANGES ON HYBRID VEHICLES WITH AN "EITHER/OR" CONTROL STRATEGY

The choice of an 80-km electric range for the hybrid vehicles was based on the ability to satisfy over 80% of the daily trips and 60% of the annual distance of a typical vehicle (see Section II). The following discussion supports the range choice, considering energy consumption and economics. Several examples of hybrid vehicles were designed with ranges of 48 and 112 km and evaluated in the same manner as the 80-km hybrids. The results were compared in terms of energy consumption, fuel consumption, initial cost, life-cycle cost, and break-even fuel price. Figures 6-13 through 6-15 show the results for the bipolar Pb/Acid, Li/FeS,and Na/S.

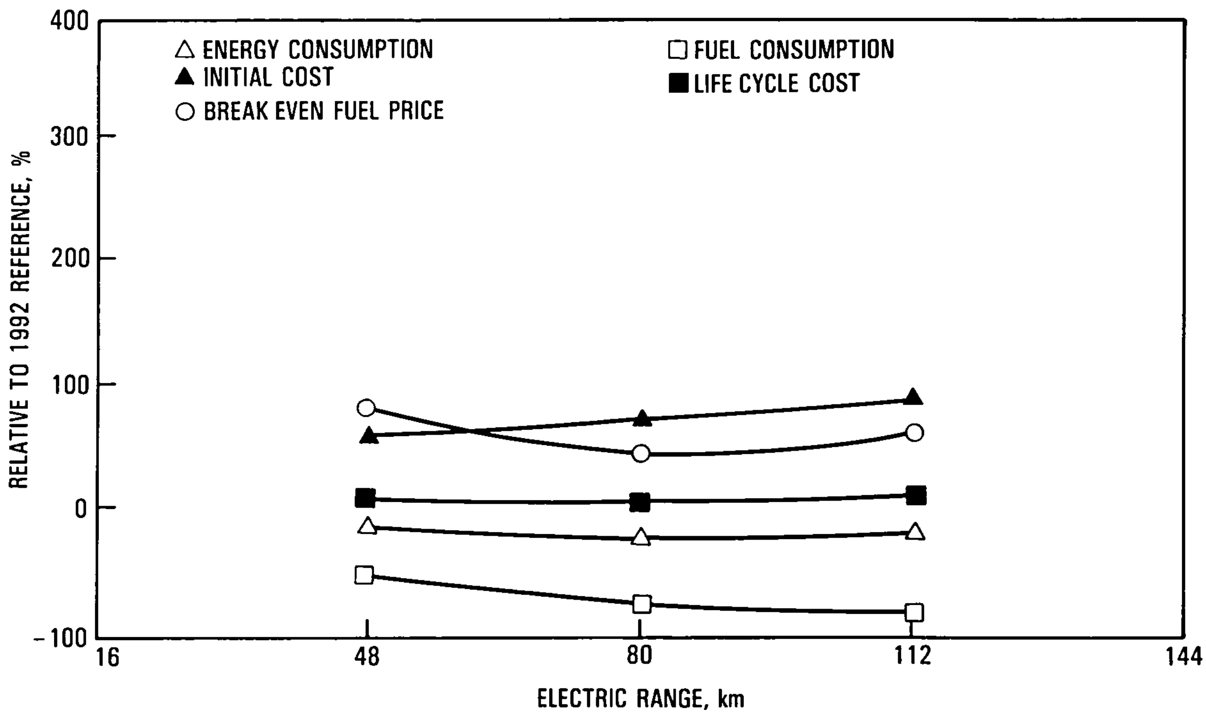


Figure 6-13. Bipolar Pb/Acid HV Sensitivity to Range

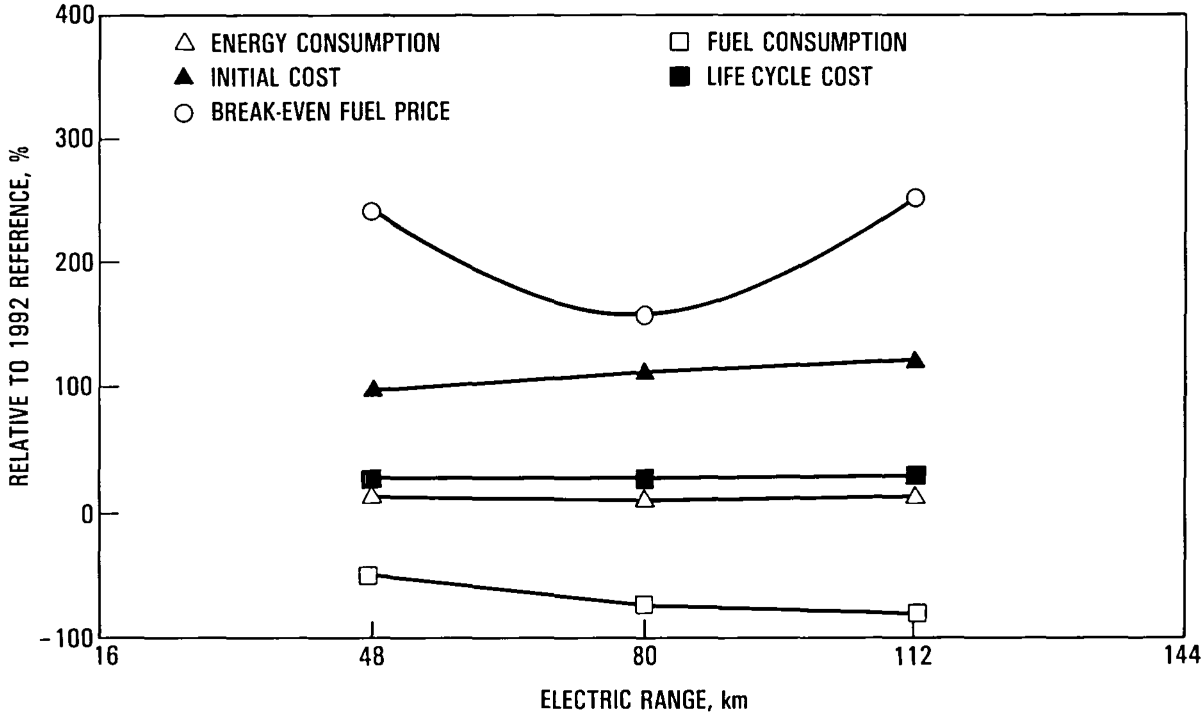


Figure 6-14. Li/FeS HV Sensitivity to Electric Range

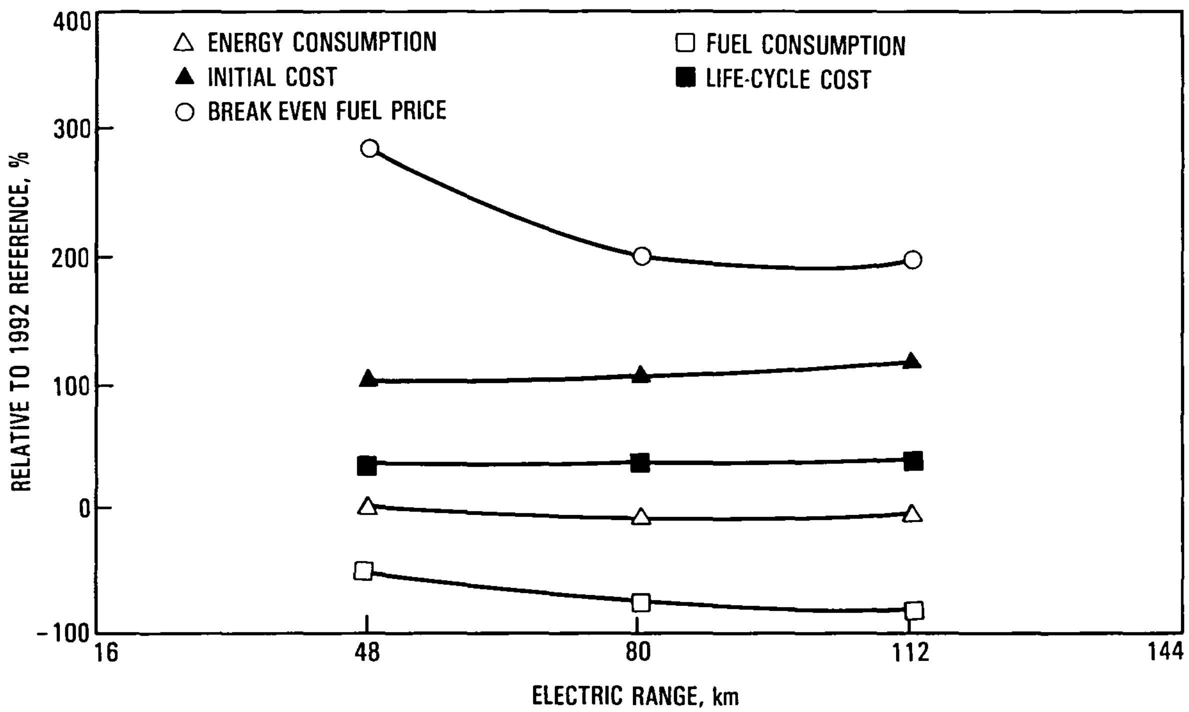


Figure 6-15. Na/S HV Sensitivity to Electric Range

The increase in initial cost is not surprising although the low dependence of relative life-cycle cost on electric range is of some interest. The Pb/Acid battery plots show a slight minimum in the energy consumption and BEFP. Results for the Li/FeS battery are similar, but the BEFP minimum is more dramatic. The minimum in the BEFP for the Na/S battery occurs at a slightly longer range than the other cases. Further investigation with the other batteries showed that the minimums occurred between 80 and 100 km in all cases. On the basis of these results, the choice of 80-km electric range for the HV does not seem to be unreasonable.

C. POWERTRAIN COST REDUCTION

The ac motor/controller is a major cost item in the vehicles of this assessment, comparable to the battery in some cases. Cost assessments were made in support of this study over 2 years ago, and electronics have continued to drop over that period. In fact, it would not be unreasonable to expect the costs to drop to 50% of those assumed (see Volume II) in the next decade. Three different batteries and two vehicle types were investigated to assess the impact of that type of cost savings. The results were drops in initial cost of 7 to 10%, decreases in life-cycle cost of 3 to 5%, and the BEFP dropped by 15 to 25%. Table 6-7 summarizes the findings.

Table 6-7. Vehicle Economic Sensitivity to 50% Motor/Controller Cost Reduction

Vehicle/ battery	% Decrease		
	Initial cost	Life-cycle cost	BEFP[a]
Vans			
Pb/Acid	10	5	17
Zn/Br_2	10	5	17
Na/S	7	4	14
Commuters			
Pb/Acid	7	3	17
Zn/Br_2	10	4	24
Na/S	10	5	22

[a]Break-even fuel price.

D. EFFECTS OF LOAD-LEVELING AND WARM-UP FUEL ON FUEL-CELL VEHICLE ECONOMICS

The fuel cells under consideration in this assessment are at conceptual stages; therefore, the certainty of design, efficiency, and economics is low. A fuel cell must be designed for the power required for the application (as opposed to energy, as in the case of most batteries) because it is an energy-conversion device. The control strategy is the key parameter in defining the power requirement for the application. The choices considered here were sizing the fuel cell for the peak-power requirements or load-leveling the fuel cell with a peaking device to meet the high-power requirements of acceleration and gradability. The energy of a flywheel is too low for the 3.3-min gradability requirement; therefore, a battery is required. The reason behind this investigation was to quantify any cost savings by using a load-leveled system. In short, the load-leveled designs were helpful to the fuel-cell systems. In the case of the solid polymer electrolyte system, conceptually designed by General Electric, the cost savings were substantial when compared to a design in which the critical parameters of the system were scaled linearly up to 36 kW ("original design") based on the 20-kW design. This should be expected because the cost of adding each kilowatt of fuel cell ranges from $200 to $300, and the cost of adding each kilowatt of lead-acid battery is approximately 20% of that amount.

The most advantageous change to the system was rescaling the subcomponents ("redesigned SPEC") to support the same fuel-cell stack at a higher current density to meet the gradability requirement (i.e., primarily the fuel supply and cooling subsystems). The 3.3-min requirement, at 90% of the peak-power capability, amounts to a constant requirement for the fuel processor because it would be impossible to store the amount of hydrogen and oxygen needed. The subcomponents were conceptually redesigned, resulting in cutting the costs of the fuel-cell system to $205/kW from $330/kW. Almost $5000 were saved as the result of this analysis; however, the question remains as to the effect of the current density on life. Table 6-8 summarizes the initial cost differences of various SPE systems as well as a load-leveled design of the phosphoric acid system.

The uncertainty of the warm-up fuel requirements has an effect on the relative economics. The fuel-cell systems require the fuel processor and cell stack to be up to operating temperature before power is available. The energy required for this warm-up must be supplied by the fuel to some degree each time the vehicle starts, depending on how long it has been since the vehicle operated and on the thermal insulation characteristics. The amount of fuel required for this purpose was estimated to be almost 100 gal of methanol annually for the SPE system designed for 36 kW. The analysis has been repeated for lower amounts of fuel, allowing for more efficient fuel utilization or better thermal insulation characteristics.

There is a noticeable difference between the "original" SPEC and the other versions; however, the BEFP tends to exaggerate the difference between the "redesigned" and "load-leveled" SPEC vehicles. In this case, only 50 gal of methanol per year causes the disparity (100% column) as illustrated by identical BEFPs when start-up fuel is eliminated from consideration. It is obvious that even without start-up fuel, the fuel-cell vehicles will not totally complete with methanol-fueled ICE vehicles.

Table 6-8. Sensitivity of Fuel-Cell Vehicle Economics

System	Initial cost, 1982$	BEFP with % start-up fuel, $/gal of methanol		
		100%	50%	0%
Original SPEFC	$23,070	$20.70	$11.80	$8.20
Redesigned SPEFC	17,550	13.30	7.60	5.30
Load-leveled SPEFC/Pb-Acid	18,030	7.60	6.20	5.30
Load-leveled PAFC/Pb-Acid	21,600	16.40	9.30	6.60

SECTION VII

CONCLUSIONS AND RECOMMENDATIONS

The primary objective of the AV Assessment is to recommend subsystem research priorities in pursuit of advanced electric and hybrid vehicles from a system perspective; that is, recommendations are made in support of the most promising systems. The primary measures of the "most promising" systems (based on the systems analyses) are relative economics and energy consumption, with more subjective parameters presented in the Preference Analyses of Volume IV. Vans and two-passenger commuter vehicles seem to be the most attractive for electric vehicle development, based on the projections of approximately equivalent life-cycle costs and substantial energy savings in many cases. The next priority would be 160-km EVs, followed by the hybrid vehicles. The least economical of the vehicle systems are the long-range electric vehicles.

Batteries are the most critical components of the advanced vehicles and the primary focus of the subsystem research priorities. It is difficult to apply a rigorous criteria for selection to the batteries with the uncertainties of technical risk and development cost outstanding. However, there are some practical considerations in ranking the systems economically. Relative initial cost is not an adequate measure because advanced vehicles cannot compete with their respective reference vehicles on that basis. In any case, relative life-cycle costs reflect the relative initial costs. Going one step further to include fuel savings (in break-even fuel prices) tends to magnify the differences in life-cycle cost out of proportion. Therefore, the life-cycle cost seems to be a reasonable measure; Figure 7-1 summarizes the relative merits of the systems in that regard. Considering the current funding situation, it is unrealistic to expect all the candidates to be supported at a level necessary to achieve the performance projections of this assessment. Hence, an arbitrary, though practical, selection of the top five candidates in each application has been boxed with dotted lines in the figure (with the exception of the 400-km range case, in which only four candidates were below 50% greater life-cycle cost than the reference vehicles).

Interestingly enough, the first three categories (starting on the left in Figure 7-1) contain the same candidates in the top five batteries: the bipolar lead/acid, nickel/zinc, conventional lead/acid, nickle/iron and lithium/iron sulfide. By increasing the design range to 240 km, the group is joined by sodium/sulfur; and the lead/acid is eliminated. At higher ranges, the bipolar lead/acid and nickel/zinc are inadequate in terms of energy capacity and are replaced by iron/air and zinc/chlorine batteries. The hybrid vehicles, with high P/E requirements for batteries, have the same top candidates as the short-range electrics.

Applying another practical screening criterion of 100% greater initial cost than the reference (note the asterisks in the figure) further limits the candidates in each application. The resulting list of priorities includes five batteries for electric-vehicle applications up to the 160-km range and two candidates for hybrids, although the development requires attention to the P/E requirements of each application.

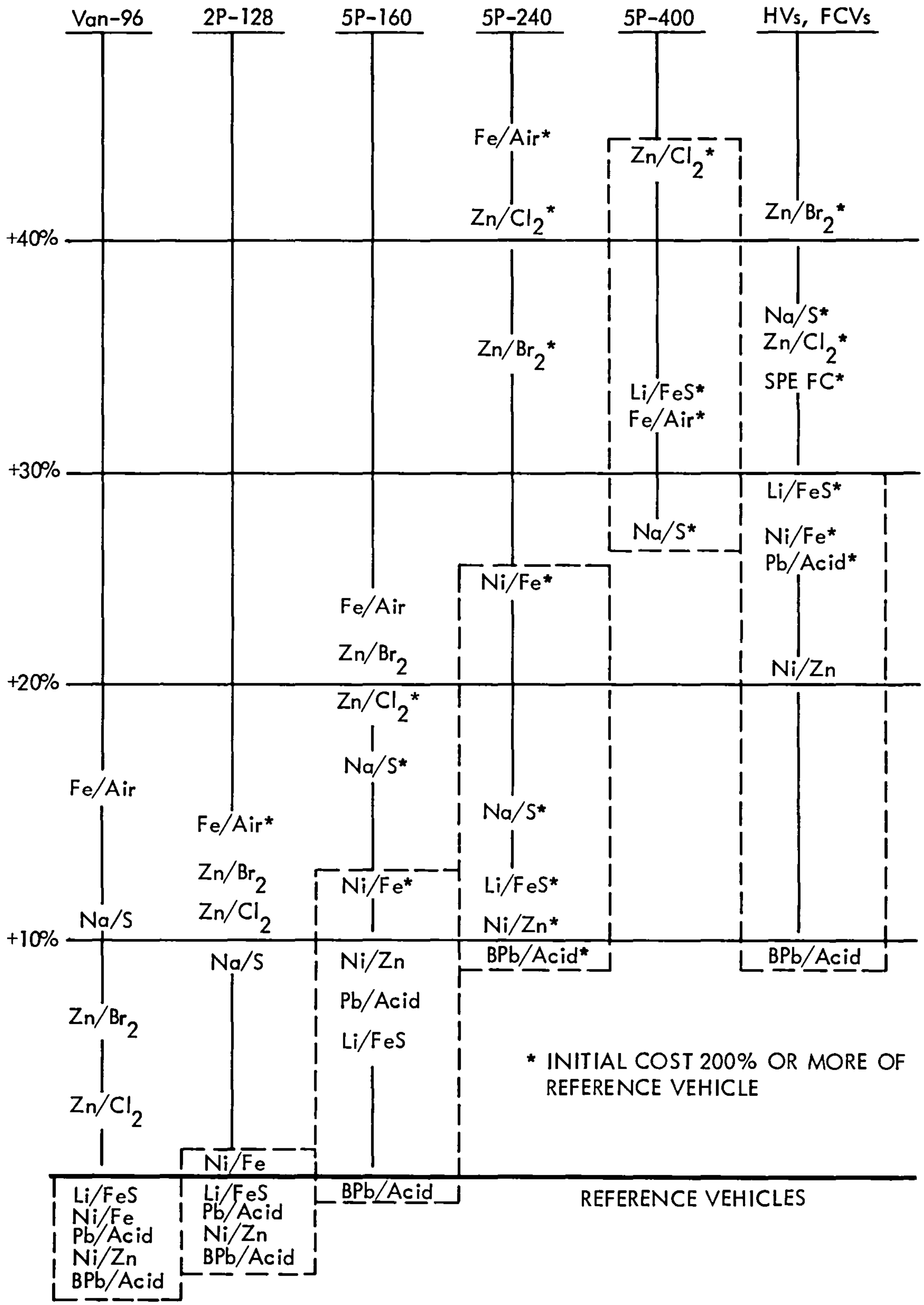


Figure 7-1. Summary of Life-Cycle Cost Relative to Reference Vehicles

The overall battery development recommendations, based on projected economics of the most promising vehicles, are listed below in order of priority with the necessary design target for the P/E ratio:

Battery	Design target
Bipolar Lead/Acid Nickel/Zinc Lead Acid Nickel/Iron Lithium/Iron Sulfide	P/E 2.1
Lithium/Iron Sulfide Lead/Acid Nickel/Zinc	P/E 1.6
Bipolar Lead/Acid Nickel/Zinc	P/E 3.8

The P/E ratio is defined as the 30-s power capability divided by the energy capacity delivered over a realistic driving cycle to the same state of charge (preferably 10 to 20%).

This method of choosing candidates is not the only possible method, and the recommendations are open to interpretation, based on the reader's faith in the vehicle projections and the actual developmental funding constraints.

Concerning the other vehicle subsystems, the choice of technologies is not as critical; and cost reduction and increased reliability should be the prime targets (motor, controller, and transmission). The sensitivity analyses showed that propulsion subsystem cost reduction could provide a benefit comparable to battery cost reduction and should not be ignored. The fuel-cell system costs must decrease and the warm-up fuel use lowered to provide an effective replacement for the primary competition, the methanol-fueled, ICE-powered vehicle.

SECTION VIII

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2-3. Characteristics of 1977 Licensed Drivers and Their Travel, U.S. Department of Transportation, Report No. 1, 1977 NPTS, 1980.

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2-6. Home to Work Trips and Travel, U.S. Department of Transportation, Report No. 4, 1977 NPTS, Appendix, 1980.

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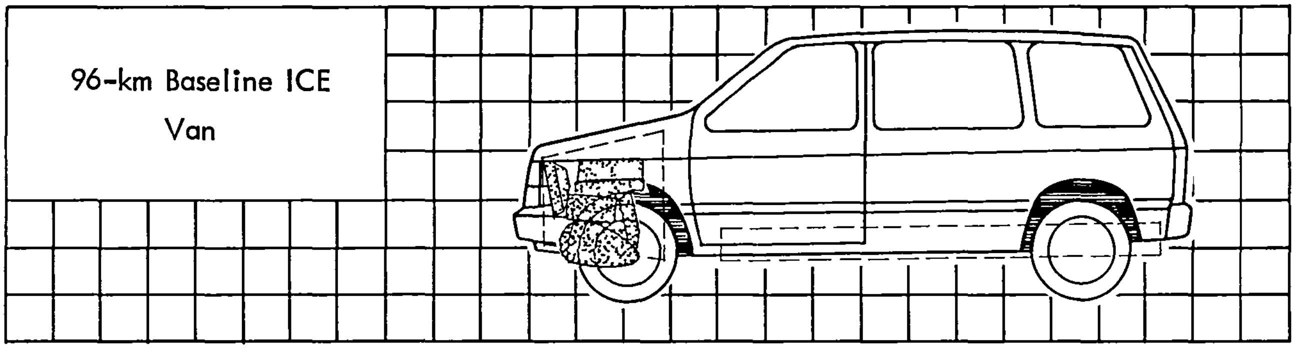
APPENDIX A

VEHICLE DATA SHEETS

VAN DATA



VEHICLE DATA

Seating Capacity..........	(Van)
Curb Weight (kg/lb).......	1080/2376
Test Weight (kg/lb).......	1375/3025
Weight Dist. [f/r (%)]....	57/43
Wheelbase (in./cm)........	113/287
Length (in./cm)...........	169/430
Width (in./cm)............	64/162
Height (in./cm)...........	68/173
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	2900/103
Fuel Capacity (gal/l).....	10/40

BATTERY

Name......................	
Weight (kg/lb)............	
Volume (l/cu ft)..........	

MOTOR

Type......................	
Weight (kg/lb)............	
Volume (l/cu ft)..........	
Rated Power (Cont. kW)....	

CONTROLLER

Type......................	
Weight (kg/lb)............	
Volume (l/cu ft)..........	
Rated Power (kW)..........	

ENGINE

Type...........................	4 cyl-SI
Compression Ratio..............	12
Weight (kg/lb).................	62/136
Volume (l/cu ft)...............	21/0.7
Rated Power (kW)...............	41.3
Fuel...........................	Methanol

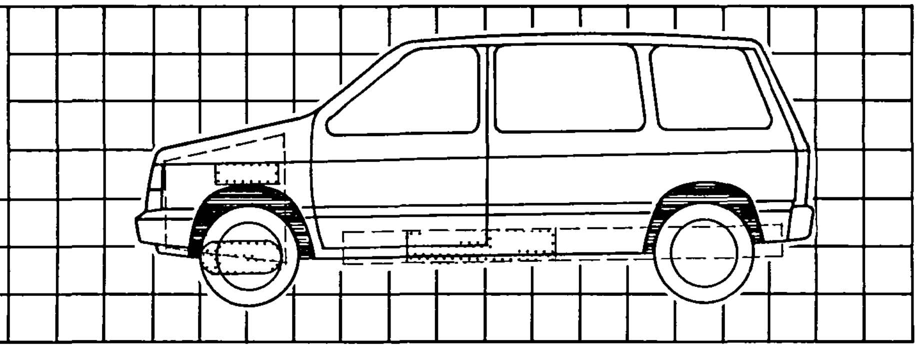
DRIVETRAIN

Motor Trans. Type..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Engine Transmission type.......	CVT
Weight (kg/lb).................	25/55
Volume (l/cm ft)...............	49/1.7
Rated Power (kW)...............	41.3

CALCULATED DATA

Range (km/mi)..................	256/160
Fuel Economy	
Electric Mode (kWh/km/mi)....	
Annual Energy (kWh)..........	
Heat Engine Mode (mpg).......	16
Annual fuel (l/g)............	2034/508
Cost - 1982$	
Initial......................	8498
Operating ($/km/mi)..........	0.19/0.30
Life Cycle ($/km/mi).........	0.20/0.32

96-km Pb-Acid EV Van



VEHICLE DATA

Seating Capacity..........	(Van)
Curb Weight (kg/lb).......	1735/3817
Test Weight (kg/lb).......	2030/4466
Weight Dist. [f/r (%)]....	56/44
Wheelbase (in./cm)........	113/287
Length (in./cm)...........	169/430
Width (in./cm)............	64/162
Height (in./cm)...........	68/173
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	2900/103
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Pb-Acid
Weight (kg/lb)............	453/997
Volume (l/cu ft)..........	216/7.6

MOTOR

Type......................	AC
Weight (kg/lb)............	76/167
Volume (l/cu ft)..........	24/0.8
Rated Power (Cont. kW)....	37

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	16/35
Volume (l/cu ft)..........	41/1.4
Rated Power (kW)..........	41.2

ENGINE

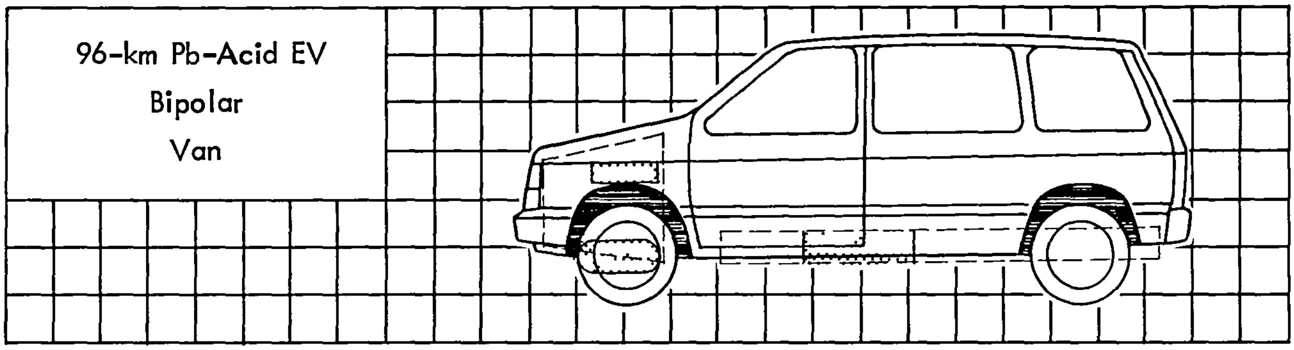
Type...........................	
Displacement...................	
Compression Ratio..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Fuel...........................	

DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	29/64
Volume (l/cu ft)...............	15/0.5
Rated Power (kW)...............	41.2
Engine Transmission type.......	
Weight (kg/lb).................	
Volume (l/cm ft)...............	
Rated Power (kW)...............	

CALCULATED DATA

Range (km/mi)..................	93/58
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.24/0.38
Annual Energy (kWh)..........	2980
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	13422
Operating ($/km/mi)..........	0.18/0.29
Life Cycle ($/km/mi).........	0.19/0.30



VEHICLE DATA

Seating Capacity..........	(Van)
Curb Weight (kg/lb).......	1510/3322
Test Weight (kg/lb).......	1805/3971
Weight Dist. [f/r (%)]....	54/46
Wheelbase (in./cm)........	113/287
Length (in./cm)...........	169/430
Width (in./cm)............	64/162
Height (in./cm)...........	68/173
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	2900/103
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Pb-Acid Bipolar
Weight (kg/lb)............	293/645
Volume (l/cu ft)..........	148/5.2

MOTOR

Type......................	AC
Weight (kg/lb)............	67/147
Volume (l/cu ft)..........	21/0.7
Rated Power (Cont. kW)....	33

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	15/33
Volume (l/cu ft)..........	37/1.3
Rated Power (kW)..........	37

ENGINE

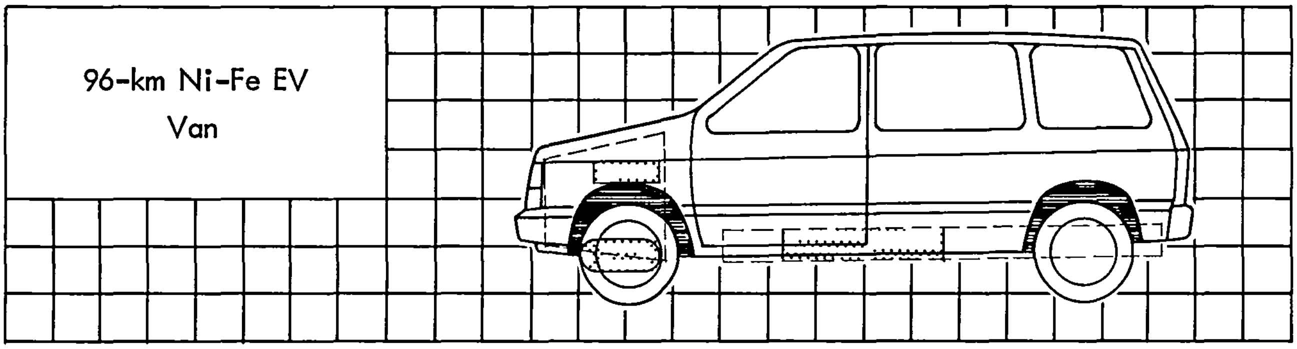
Type...........................	
Displacement...................	
Compression Ratio..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Fuel...........................	

DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	26/57
Volume (l/cu ft)...............	13/0.5
Rated Power (kW)...............	36.6
Engine Transmission type.......	
Weight (kg/lb).................	
Volume (l/cm ft)...............	
Rated Power (kW)...............	

CALCULATED DATA

Range (km/mi)..................	94/59
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.19/0.30
Annual Energy (kWh)..........	2651
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	11968
Operating ($/km/mi)..........	0.15/0.24
Life Cycle ($/km/mi).........	0.16/0.26



VEHICLE DATA

Seating Capacity..........	(Van)
Curb Weight (kg/lb).......	1644/3617
Test Weight (kg/lb).......	1939/4266
Weight Dist. [f/r (%)]....	56/44
Wheelbase (in./cm)........	113/287
Length (in./cm)...........	169/430
Width (in./cm)............	64/162
Height (in./cm)...........	68/173
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	2900/103
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Ni-Fe
Weight (kg/lb)............	388/854
Volume (l/cu ft)..........	232/8.2

MOTOR

Type......................	AC
Weight (kg/lb)............	72/158
Volume (l/cu ft)..........	23/0.8
Rated Power (Cont. kW)....	35.4

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	16/35
Volume (l/cu ft)..........	39/1.4
Rated Power (kW)..........	39.4

ENGINE

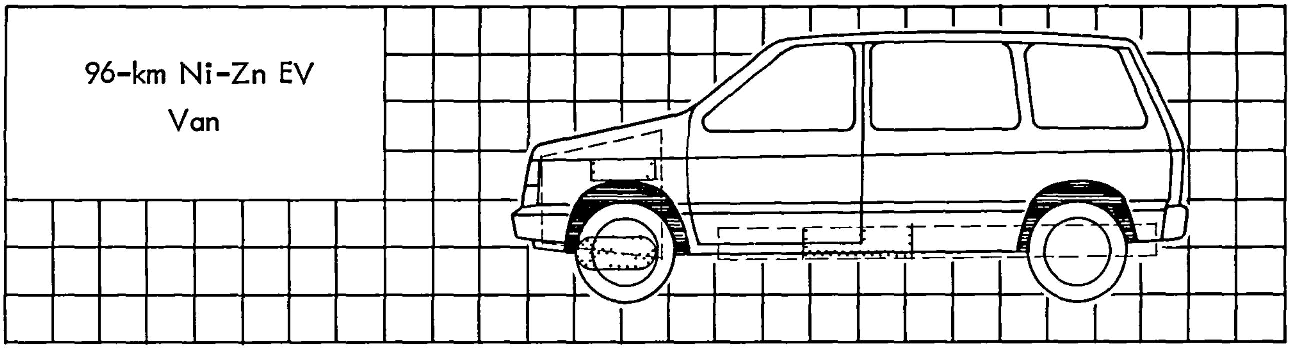
Type...........................	
Displacement...................	
Compression Ratio..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Fuel...........................	

DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	28/62
Volume (l/cu ft)...............	14/0.5
Rated Power (kW)...............	39.4
Engine Transmission type.......	
Weight (kg/lb).................	
Volume (l/cm ft)...............	
Rated Power (kW)...............	

CALCULATED DATA

Range (km/mi)..................	98/61
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.32/0.51
Annual Energy (kWh)..........	3941
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	14967
Operating ($/km/mi)..........	0.18/0.29
Life Cycle ($/km/mi).........	0.20/0.32



VEHICLE DATA

Seating Capacity..........	(Van)
Curb Weight (kg/lb).......	1455/320
Test Weight (kg/lb).......	1750/3850
Weight Dist. [f/r (%)]....	57/43
Wheelbase (in./cm)........	113/287
Length (in./cm)...........	169/430
Width (in./cm)............	64/162
Height (in./cm)...........	68/173
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	2900/103
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Ni-Zn
Weight (kg/lb)............	254/559
Volume (l/cu ft)..........	152/5.4

MOTOR

Type......................	AC
Weight (kg/lb)............	65/143
Volume (l/cu ft)..........	21/0.7
Rated Power (Cont. kW)....	32

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	14/31
Volume (l/cu ft)..........	36/1.3
Rated Power (kW)..........	35.5

ENGINE

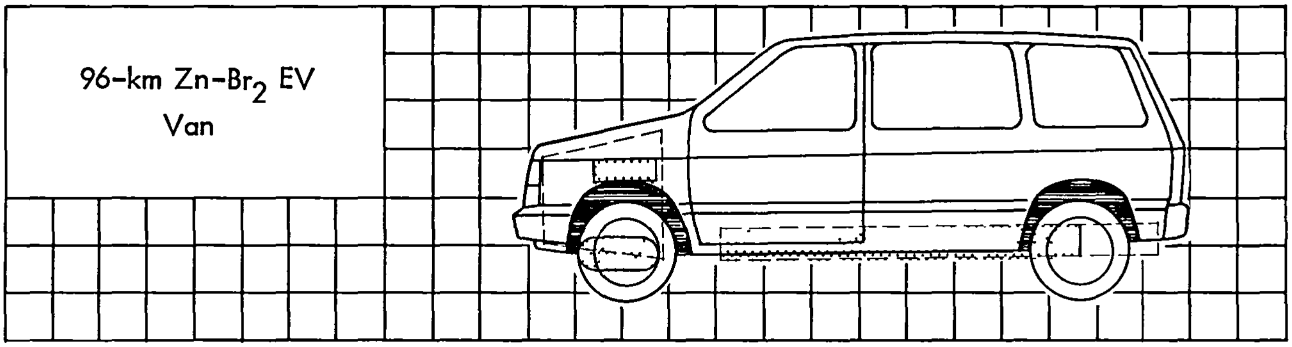
Type...........................	
Displacement...................	
Compression Ratio..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Fuel...........................	

DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	25/55
Volume (l/cu ft)...............	13/0.5
Rated Power (kW)...............	35.5
Engine Transmission type.......	
Weight (kg/lb).................	
Volume (l/cm ft)...............	
Rated Power (kW)...............	

CALCULATED DATA

Range (km/mi)..................	94/59
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.23/0.36
Annual Energy (kWh)..........	2863
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	12623
Operating ($/km/mi)..........	0.19/0.30
Life Cycle ($/km/mi).........	0.19/0.30



VEHICLE DATA

Seating Capacity..........	(Van)
Curb Weight (kg/lb).......	1723/3791
Test Weight (kg/lb).......	2018/4440
Weight Dist. [f/r (%)]....	53/47
Wheelbase (in./cm)........	113/287
Length (in./cm)...........	169/430
Width (in./cm)............	64/162
Height (in./cm)...........	68/173
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	2900/103
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Zn-Br_2
Weight (kg/lb)............	444/977
Volume (l/cu ft)..........	444/15.7

MOTOR

Type......................	AC
Weight (kg/lb)............	75/165
Volume (l/cu ft)..........	24/0.8
Rated Power (Cont. kW)....	36.9

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	16/35
Volume (l/cu ft)..........	19/0.7
Rated Power (kW)..........	41.0

ENGINE

Type...........................	
Displacement...................	
Compression Ratio..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Fuel...........................	

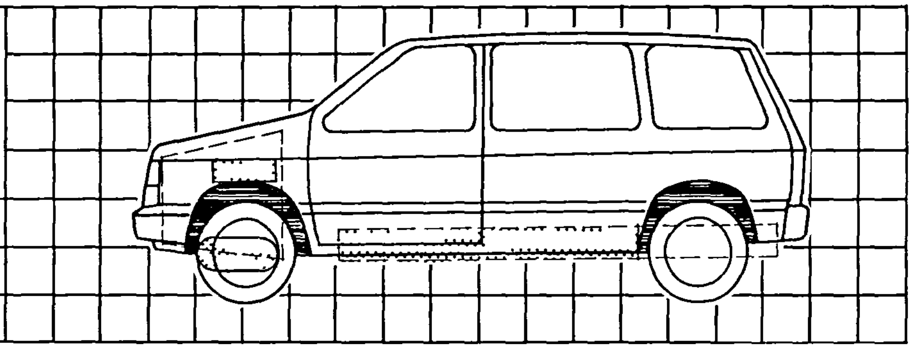
DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	29/64
Volume (l/cu ft)...............	15/0.5
Rated Power (kW)...............	41.0
Engine Transmission type.......	
Weight (kg/lb).................	
Volume (l/cm ft)...............	
Rated Power (kW)...............	

CALCULATED DATA

Range (km/mi)..................	96/60
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.40/0.64
Annual Energy (kWh)..........	5701
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	13383
Operating ($/km/mi)..........	0.20/0.32
Life Cycle ($/km/mi).........	0.20/0.32

96-km $Zn-Cl_2$ EV Van



VEHICLE DATA

Seating Capacity..........	(Van)
Curb Weight (kg/lb).......	1592/3502
Test Weight (kg/lb).......	1887/4151
Weight Dist. [f/r (%)]....	56/44
Wheelbase (in./cm)........	113/287
Length (in./cm)...........	169/430
Width (in./cm)............	64/162
Height (in./cm)...........	68/173
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	2900/103
Fuel Capacity (gal/l).....	

BATTERY

Name......................	$Zn-Cl_2$
Weight (kg/lb)............	351/772
Volume (l/cu ft)..........	394/13.9

MOTOR

Type......................	AC
Weight (kg/lb)............	70/154
Volume (l/cu ft)..........	22/0.8
Rated Power (Cont. kW)....	34.5

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	15/33
Volume (l/cu ft)..........	18/0.6
Rated Power (kW)..........	38.3

ENGINE

Type...........................	
Displacement...................	
Compression Ratio..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Fuel...........................	

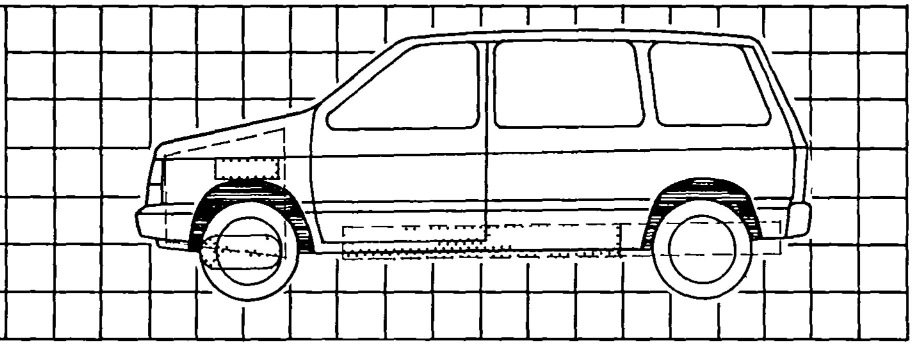
DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	27/59
Volume (l/cu ft)...............	14/0.5
Rated Power (kW)...............	38.3
Engine Transmission type.......	
Weight (kg/lb).................	
Volume (l/cm ft)...............	
Rated Power (kW)...............	

CALCULATED DATA

Range (km/mi)..................	93/58
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.35/0.57
Annual Energy (kWh)..........	5049
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	15161
Operating ($/km/mi)..........	0.17/0.27
Life Cycle ($/km/mi).........	0.19/0.30

96-km Fe-Air EV
Van



VEHICLE DATA

Seating Capacity..........	(Van)
Curb Weight (kg/lb).......	1492/3282
Test Weight (kg/lb).......	1787/3931
Weight Dist. [f/r (%)]....	57/43
Wheelbase (in./cm)........	113/287
Length (in./cm)...........	169/430
Width (in./cm)............	64/162
Height (in./cm)...........	68/173
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	2900/103
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Fe-Air
Weight (kg/lb)............	280/616
Volume (l/cu ft)..........	353/12.4

MOTOR

Type......................	AC
Weight (kg/lb)............	67/147
Volume (l/cu ft)..........	21/0.7
Rated Power (Cont. kW)....	32.7

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	15/33
Volume (l/cu ft)..........	36/1.3
Rated Power (kW)..........	36

ENGINE

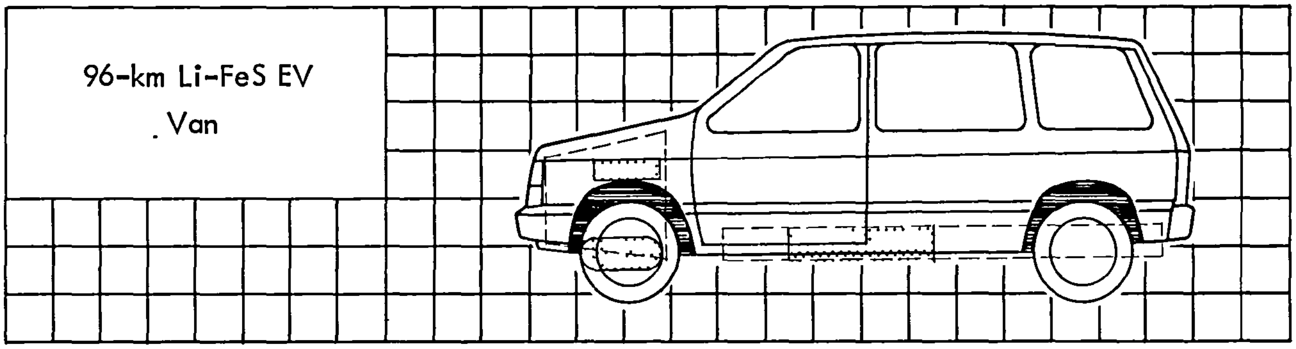
Type...........................	
Displacement...................	
Compression Ratio..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Fuel...........................	

DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	26/57
Volume (l/cu ft)...............	13/0.5
Rated Power (kW)...............	36.3
Engine Transmission type.......	
Weight (kg/lb).................	
Volume (l/cm ft)...............	
Rated Power (kW)...............	

CALCULATED DATA

Range (km/mi)..................	96/60
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.39/0.63
Annual Energy (kWh)..........	4871
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	12954
Operating ($/km/mi)..........	0.22/0.35
Life Cycle ($/km/mi).........	0.23/0.37



96-km Li-FeS EV
Van

VEHICLE DATA

Seating Capacity..........	(Van)
Curb Weight (kg/lb).......	1486/3269
Test Weight (kg/lb).......	1781/3918
Weight Dist. [f/r (%)]....	57/43
Wheelbase (in./cm)........	113/287
Length (in./cm)...........	169/430
Width (in./cm)............	64/162
Height (in./cm)...........	68/173
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	2900/103
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Li-FeS
Weight (kg/lb)............	276/607
Volume (l/cu ft)..........	197/7.0

MOTOR

Type......................	AC
Weight (kg/lb)............	66/145
Volume (l/cu ft)..........	21/0.7
Rated Power (Cont. kW)....	32.5

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	14/31
Volume (l/cu ft)..........	17/0.6
Rated Power (kW)..........	36.2

ENGINE

Type............................	
Displacement....................	
Compression Ratio...............	
Weight (kg/lb)..................	
Volume (l/cu ft)................	
Rated Power (kW)................	
Fuel............................	

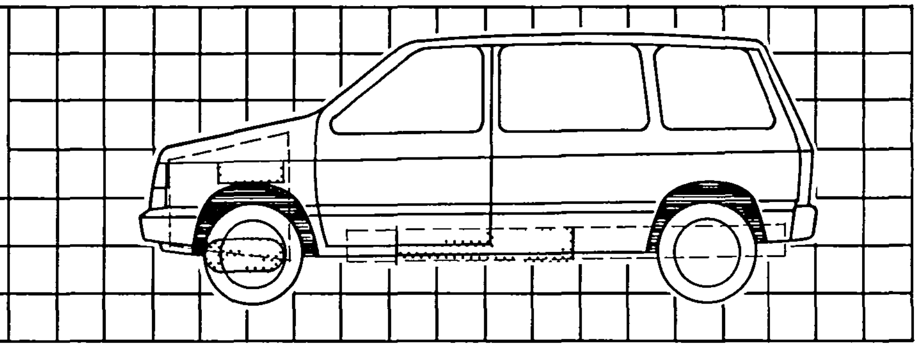
DRIVETRAIN

Motor Trans. Type...............	Fixed Reduction
Weight (kg/lb)..................	26/57
Volume (l/cu ft)................	13/0.5
Rated Power (kW)................	36.2
Engine Transmission type.......	
Weight (kg/lb)..................	
Volume (l/cm ft)................	
Rated Power (kW)................	

CALCULATED DATA

Range (km/mi)...................	99/62
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.28/0.44
Annual Energy (kWh)..........	3967
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	13800
Operating ($/km/mi)..........	0.18/0.29
Life Cycle ($/km/mi).........	0.18/0.29

96-km Na-S EV
Van



VEHICLE DATA

Seating Capacity..........	(Van)
Curb Weight (kg/lb).......	1366/3005
Test Weight (kg/lb).......	1661/3654
Weight Dist. [f/r (%)]....	57/43
Wheelbase (in./cm)........	113/287
Length (in./cm)...........	169/430
Width (in./cm)............	64/162
Height (in./cm)...........	68/173
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	2900/103
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Na-S
Weight (kg/lb)............	191/420
Volume (l/cu ft)..........	211/7.5

MOTOR

Type......................	AC
Weight (kg/lb)............	62/136
Volume (l/cu ft)..........	20/0.7
Rated Power (Cont. kW)....	30.4

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	13/29
Volume (l/cu ft)..........	34/1.2
Rated Power (kW)..........	33.7

ENGINE

Type............................	
Displacement....................	
Compression Ratio...............	
Weight (kg/lb)..................	
Volume (l/cu ft)................	
Rated Power (kW)................	
Fuel............................	

DRIVETRAIN

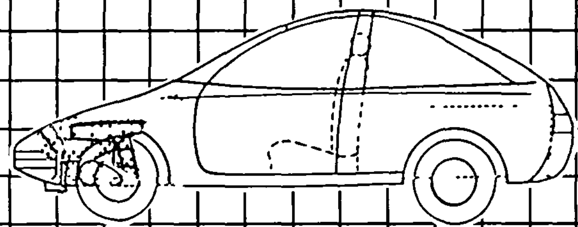
Motor Trans. Type...............	Fixed Reduction
Weight (kg/lb)..................	24/53
Volume (l/cu ft)................	12/0.4
Rated Power (kW)................	33.7
Engine Transmission type........	
Weight (kg/lb)..................	
Volume (l/cm ft)................	
Rated Power (kW)................	

CALCULATED DATA

Range (km/mi)...................	94/59
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.24/0.38
Annual Energy (kWh)..........	2941
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	14230
Operating ($/km/mi)..........	0.21/0.34
Life Cycle ($/km/mi).........	0.22/0.35

TWO-PASSENGER DATA

128-km Baseline ICE
2-Passenger



VEHICLE DATA

Seating Capacity..........	2
Curb Weight (kg/lb).......	500/1100
Test Weight (kg/lb).......	636/1399
Weight Dist. [f/r (%)]....	57/43
Wheelbase (in./cm)........	82/209
Length (in./cm)...........	137/347
Width (in./cm)............	38/97
Height (in./cm)...........	52/131
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	$300^+/10.6^+$
Fuel Capacity (gal/l).....	10/40

BATTERY

Name......................	
Weight (kg/lb)............	
Volume (l/cu ft)..........	

MOTOR

Type......................	
Weight (kg/lb)............	
Volume (l/cu ft)..........	
Rated Power (Cont. kW)....	

CONTROLLER

Type......................	
Weight (kg/lb)............	
Volume (l/cu ft)..........	
Rated Power (kW)..........	

ENGINE

Type...........................	4 cyl-SI
Compression Ratio..............	12
Weight (kg/lb).................	37/81
Volume (l/cu ft)...............	10/0.4
Rated Power (kW)...............	19
Fuel...........................	Methanol

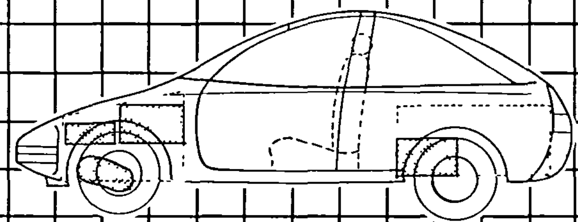
DRIVETRAIN

Motor Trans. Type..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Engine Transmission type.......	CVT
Weight (kg/lb).................	15/33
Volume (l/cm ft)...............	22/0.8
Rated Power (kW)...............	19

CALCULATED DATA

Range (km/mi)..................	496/310
Fuel Economy	
Electric Mode (kWh/km/mi)....	
Annual Energy (kWh)..........	
Heat Engine Mode (mpg).......	31
Annual fuel (l/g)............	899/225
Cost - 1982$	
Initial......................	4425
Operating ($/km/mi)..........	0.14/0.22
Life Cycle ($/km/mi).........	0.14/0.22

128-km Pb-Acid EV
2-Passenger



VEHICLE DATA

Seating Capacity	2
Curb Weight (kg/lb)	933/2053
Test Weight (kg/lb)	1069/2352
Weight Dist. [f/r (%)]	55/45
Wheelbase (in./cm)	82/209
Length (in./cm)	137/347
Width (in./cm)	38/97
Height (in./cm)	52/131
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	$300^{+}/10.6^{+}$
Fuel Capacity (gal/l)	

BATTERY

Name	Pb-Acid
Weight (kg/lb)	306/673
Volume (l/cu ft)	145/5.1

MOTOR

Type	AC
Weight (kg/lb)	34/75
Volume (l/cu ft)	11/0.4
Rated Power (Cont. kW)	16.8

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	11/24
Volume (l/cu ft)	28/1.0
Rated Power (kW)	27.7

ENGINE

Type	
Displacement	
Compression Ratio	
Weight (kg/lb)	
Volume (l/cu ft)	
Rated Power (kW)	
Fuel	

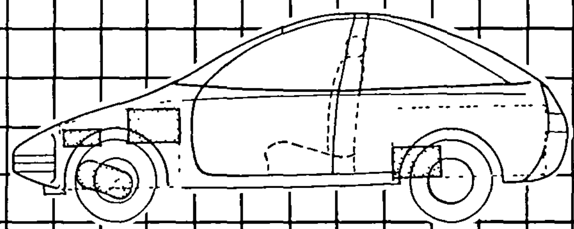
DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	20/44
Volume (l/cu ft)	10/0.4
Rated Power (kW)	27.7
Engine Transmission type	
Weight (kg/lb)	
Volume (l/cm ft)	
Rated Power (kW)	

CALCULATED DATA

Range (km/mi)	131/82
Fuel Economy	
Electric Mode (kWh/km/mi)	0.13/0.21
Annual Energy (kWh)	1531
Heat Engine Mode (mpg)	
Annual fuel (l/g)	
Cost - 1982$	
Initial	7608
Operating ($/km/mi)	0.13/0.21
Life Cycle ($/km/mi)	0.14/0.22

128-km Bipolar Pb-Acid EV
2-Passenger



VEHICLE DATA

Seating Capacity	2
Curb Weight (kg/lb)	808/1777
Test Weight (kg/lb)	944/2077
Weight Dist. [f/r (%)]	49/51
Wheelbase (in./cm)	82/209
Length (in./cm)	137/347
Width (in./cm)	38/97
Height (in./cm)	52/131
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	$300^{+}/10.6^{+}$
Fuel Capacity (gal/l)	

BATTERY

Name	Pb-Acid Bipolar
Weight (kg/lb)	217/477
Volume (l/cu ft)	110/3.9

MOTOR

Type	AC
Weight (kg/lb)	30/66
Volume (l/cu ft)	10/0.4
Rated Power (Cont. kW)	14.9

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	10/22
Volume (l/cu ft)	24/0.8
Rated Power (kW)	24.4

ENGINE

Type	
Displacement	
Compression Ratio	
Weight (kg/lb)	
Volume (l/cu ft)	
Rated Power (kW)	
Fuel	

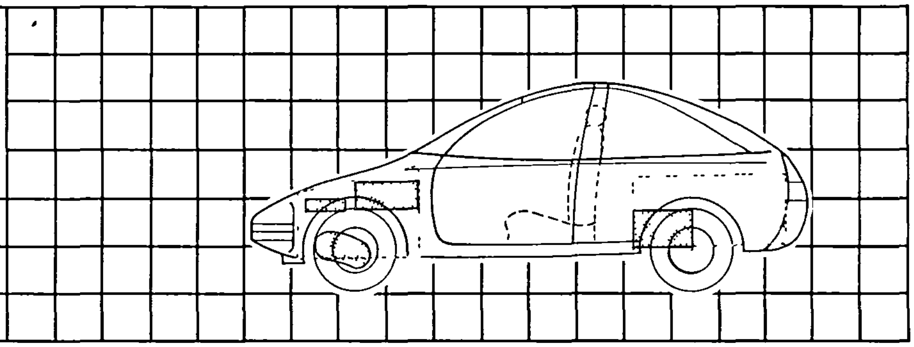
DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	17/37
Volume (l/cu ft)	8/0.3
Rated Power (kW)	24.4
Engine Transmission type	
Weight (kg/lb)	
Volume (l/cm ft)	
Rated Power (kW)	

CALCULATED DATA

Range (km/mi)	126/79
Fuel Economy	
Electric Mode (kWh/km/mi)	0.10/0.16
Annual Energy (kWh)	1214
Heat Engine Mode (mpg)	
Annual fuel (l/g)	
Cost - 1982$	
Initial	6587
Operating ($/km/mi)	0.11/0.18
Life Cycle ($/km/mi)	0.12/0.19

128-km Ni-Fe EV
2-Passenger



VEHICLE DATA

Seating Capacity..........	2
Curb Weight (kg/lb).......	849/1868
Test Weight (kg/lb).......	985/2167
Weight Dist. [f/r (%)]....	55/45
Wheelbase (in./cm)........	82/209
Length (in./cm)...........	137/347
Width (in./cm)............	38/97
Height (in./cm)...........	52/131
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	300+/10.6+
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Ni-Fe
Weight (kg/lb)............	246/541
Volume (l/cu ft)..........	144/5.1

MOTOR

Type......................	AC
Weight (kg/lb)............	32/70
Volume (l/cu ft)..........	10/0.4
Rated Power (Cont. kW)....	15.5

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	10/22
Volume (l/cu ft)..........	26/0.9
Rated Power (kW)..........	25.5

ENGINE

Type.........................	
Displacement.................	
Compression Ratio............	
Weight (kg/lb)...............	
Volume (l/cu ft).............	
Rated Power (kW).............	
Fuel.........................	

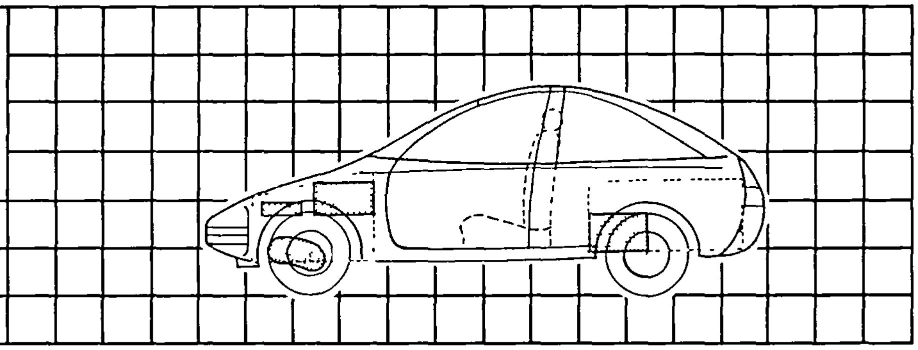
DRIVETRAIN

Motor Trans. Type............	Fixed Reduction
Weight (kg/lb)...............	18/40
Volume (l/cu ft).............	9/0.3
Rated Power (kW).............	25.5
Engine Transmission type.....	
Weight (kg/lb)...............	
Volume (l/cm ft).............	
Rated Power (kW).............	

CALCULATED DATA

Range (km/mi)................	133/83
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.17/0.27
Annual Energy (kWh)..........	1990
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	8555
Operating ($/km/mi)..........	0.13/0.21
Life Cycle ($/km/mi).........	0.14/0.22

128-km Ni-Zn EV
2-Passenger



VEHICLE DATA

Seating Capacity..........	2
Curb Weight (kg/lb).......	735/1617
Test Weight (kg/lb).......	871/1916
Weight Dist. [f/r (%)]....	52/48
Wheelbase (in./cm)........	82/209
Length (in./cm)...........	137/347
Width (in./cm)............	38/97
Height (in./cm)...........	52/131
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	300+/10.6+
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Ni-Zn
Weight (kg/lb)............	165/363
Volume (l/cu ft)..........	99/3.5

MOTOR

Type......................	AC
Weight (kg/lb)............	28/62
Volume (l/cu ft)..........	9/0.3
Rated Power (Cont. kW)....	13.7

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	9/20
Volume (l/cu ft)..........	23/0.8
Rated Power (kW)..........	22.6

ENGINE

Type......................	
Displacement..............	
Compression Ratio.........	
Weight (kg/lb)............	
Volume (l/cu ft)..........	
Rated Power (kW)..........	
Fuel......................	

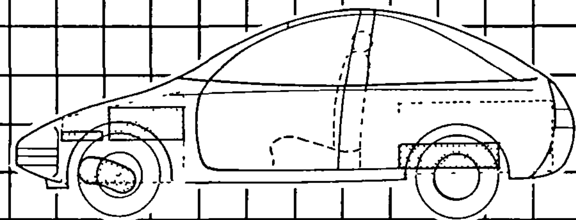
DRIVETRAIN

Motor Trans. Type.........	Fixed Reduction
Weight (kg/lb)............	16/35
Volume (l/cu ft)..........	8/0.3
Rated Power (kW)..........	22.6
Engine Transmission type.......	
Weight (kg/lb)............	
Volume (l/cm ft)..........	
Rated Power (kW)..........	

CALCULATED DATA

Range (km/mi).............	126/79
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.12/0.19
Annual Energy (kWh)........	1434
Heat Engine Mode (mpg).......	
Annual fuel (l/g)...........	
Cost - 1982$	
Initial.....................	6756
Operating ($/km/mi)..........	0.12/0.19
Life Cycle ($/km/mi).........	0.13/0.20

128-km $Zn\text{-}Br_2$ EV
2-Passenger



VEHICLE DATA

Seating Capacity	2
Curb Weight (kg/lb)	969/2132
Test Weight (kg/lb)	1105/2431
Weight Dist. [f/r (%)]	49/51
Wheelbase (in./cm)	82/209
Length (in./cm)	137/347
Width (in./cm)	38/97
Height (in./cm)	52/131
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	$300^{+}/10.6^{+}$
Fuel Capacity (gal/l)	

BATTERY

Name	$Zn\text{-}Br_2$
Weight (kg/lb)	332/730
Volume (l/cu ft)	257/9.1

MOTOR

Type	AC
Weight (kg/lb)	36/79
Volume (l/cu ft)	11/0.4
Rated Power (Cont. kW)	17.4

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	11/24
Volume (l/cu ft)	29/1.0
Rated Power (kW)	28.6

ENGINE

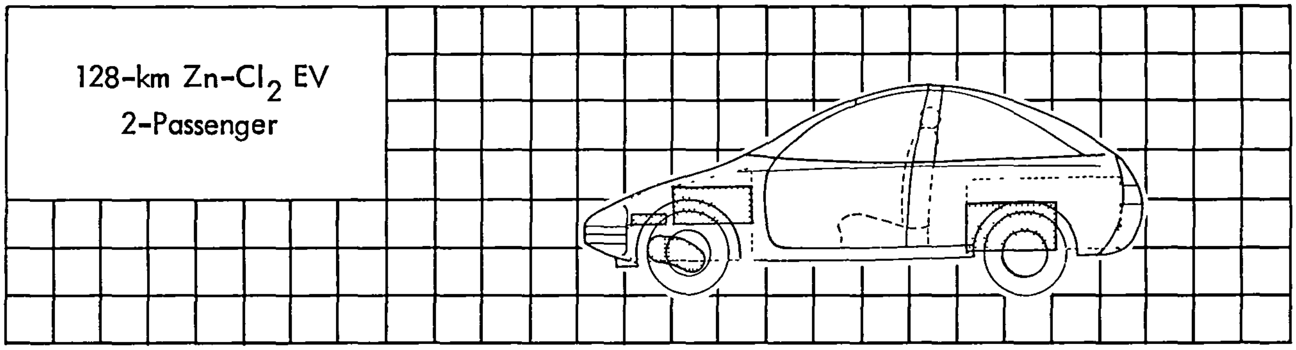
Type	
Displacement	
Compression Ratio	
Weight (kg/lb)	
Volume (l/cu ft)	
Rated Power (kW)	
Fuel	

DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	20/44
Volume (l/cu ft)	10/0.4
Rated Power (kW)	28.6
Engine Transmission type	
Weight (kg/lb)	
Volume (l/cm ft)	
Rated Power (kW)	

CALCULATED DATA

Range (km/mi)	130/81
Fuel Economy	
Electric Mode (kWh/km/mi)	0.24/0.38
Annual Energy (kWh)	2820
Heat Engine Mode (mpg)	
Annual fuel (l/g)	
Cost - 1982$	
Initial	7821
Operating ($/km/mi)	0.15/0.24
Life Cycle ($/km/mi)	0.15/0.24



VEHICLE DATA

Seating Capacity..........	2
Curb Weight (kg/lb).......	878/1932
Test Weight (kg/lb).......	1014/2231
Weight Dist. [f/r (%)]....	55/45
Wheelbase (in./cm)........	82/209
Length (in./cm)...........	137/347
Width (in./cm)............	38/97
Height (in./cm)...........	52/131
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	$300^+/10.6^+$
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Zn-Cl_2
Weight (kg/lb)............	267/587
Volume (l/cu ft)..........	225/8

MOTOR

Type......................	AC
Weight (kg/lb)............	33/73
Volume (l/cu ft)..........	10/0.4
Rated Power (Cont. kW)....	16

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	11/24
Volume (l/cu ft)..........	26/0.9
Rated Power (kW)..........	26.3

ENGINE

Type...........................	
Displacement...................	
Compression Ratio..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Fuel...........................	

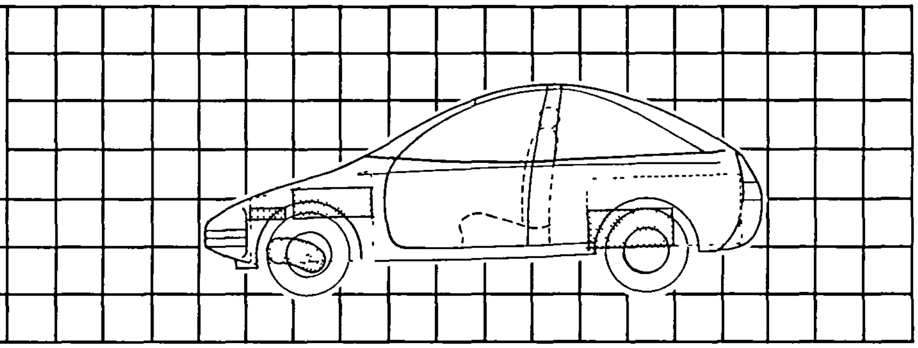
DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	19/42
Volume (l/cu ft)...............	9/0.3
Rated Power (kW)...............	26.3
Engine Transmission type.......	
Weight (kg/lb).................	
Volume (l/cm ft)...............	
Rated Power (kW)...............	

CALCULATED DATA

Range (km/mi)..................	130/81
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.20/0.32
Annual Energy (kWh)..........	2341
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	9195
Operating ($/km/mi)..........	0.14/0.22
Life Cycle ($/km/mi).........	0.16/0.26

128-km Fe-Air EV
2-Passenger



VEHICLE DATA

Seating Capacity..........	2
Curb Weight (kg/lb).......	788/1734
Test Weight (kg/lb).......	924/2033
Weight Dist. [f/r (%)]....	55/45
Wheelbase (in./cm)........	82/209
Length (in./cm)...........	137/347
Width (in./cm)............	38/97
Height (in./cm)...........	52/131
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	$300^+/10.6^+$
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Fe-Air
Weight (kg/lb)............	203/447
Volume (l/cu ft)..........	187/6.6

MOTOR

Type......................	AC
Weight (kg/lb)............	30/66
Volume (l/cu ft)..........	9/0.3
Rated Power (Cont. kW)....	14.6

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	10/22
Volume (l/cu ft)..........	24/0.8
Rated Power (kW)..........	23.9

ENGINE

Type...........................	
Displacement...................	
Compression Ratio..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Fuel...........................	

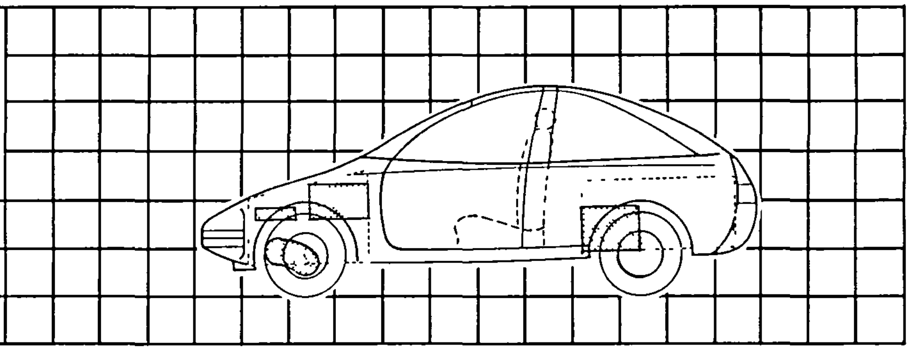
DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	17/37
Volume (l/cu ft)...............	9/0.3
Rated Power (kW)...............	23.9
Engine Transmission type.......	
Weight (kg/lb).................	
Volume (l/cm ft)...............	
Rated Power (kW)...............	

CALCULATED DATA

Range (km/mi)..................	133/83
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.21/0.34
Annual Energy (kWh)..........	2551
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	7413
Operating ($/km/mi)..........	0.17/0.27
Life Cycle ($/km/mi).........	0.16/0.26

128-km Li-FeS EV
2-Passenger



VEHICLE DATA

Seating Capacity..........	2
Curb Weight (kg/lb).......	743/1635
Test Weight (kg/lb).......	879/1934
Weight Dist. [f/r (%)]....	55/45
Wheelbase (in./cm)........	82/209
Length (in./cm)...........	137/347
Width (in./cm)............	38/97
Height (in./cm)...........	52/131
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	$300^{+}/10.6^{+}$
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Li-FeS
Weight (kg/lb)............	171/376
Volume (l/cu ft)..........	155/5.5

MOTOR

Type......................	AC
Weight (kg/lb)............	28/62
Volume (l/cu ft)..........	9/0.3
Rated Power (Cont. kW)....	13.9

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	9/20
Volume (l/cu ft)..........	23/0.8
Rated Power (kW)..........	22.8

ENGINE

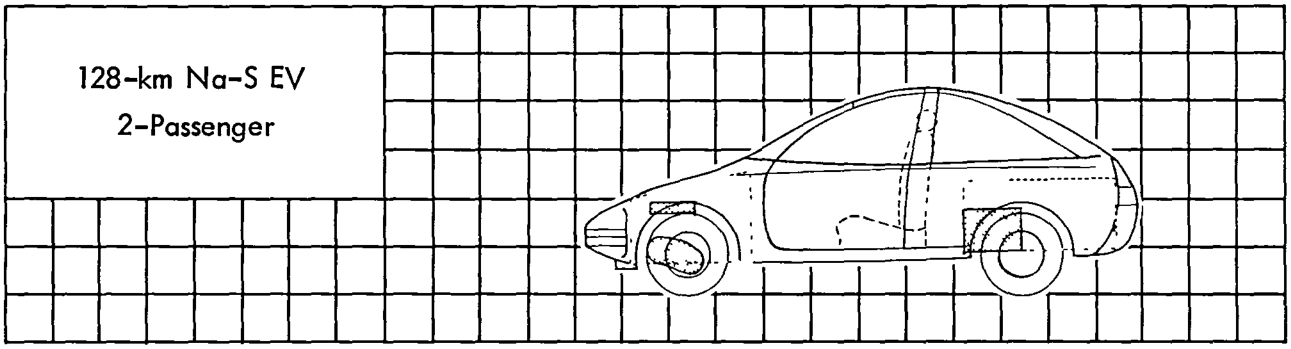
Type...........................	
Displacement...................	
Compression Ratio..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Fuel...........................	

DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	16/35
Volume (l/cu ft)...............	8/0.3
Rated Power (kW)...............	22.8
Engine Transmission type.......	
Weight (kg/lb).................	
Volume (l/cm ft)...............	
Rated Power (kW)...............	

CALCULATED DATA

Range (km/mi)..................	128/80
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.14/0.23
Annual Energy (kWh)..........	1717
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	7738
Operating ($/km/mi)..........	0.14/0.23
Life Cycle ($/km/mi).........	0.14/0.23



VEHICLE DATA

Seating Capacity..........	2
Curb Weight (kg/lb).......	667/1467
Test Weight (kg/lb).......	803/1767
Weight Dist. [f/r (%)]....	47/53
Wheelbase (in./cm)........	82/209
Length (in./cm)...........	137/347
Width (in./cm)............	38/97
Height (in./cm)...........	52/131
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	300+/10.6+
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Na-S
Weight (kg/lb)............	118/260
Volume (l/cu ft)..........	109/3.9

MOTOR

Type......................	AC
Weight (kg/lb)............	26/57
Volume (l/cu ft)..........	8/0.3
Rated Power (Cont. kW)....	12.7

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	8/18
Volume (l/cu ft)..........	21/0.7
Rated Power (kW)..........	20.8

ENGINE

Type...........................	
Displacement...................	
Compression Ratio..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Fuel...........................	

DRIVETRAIN

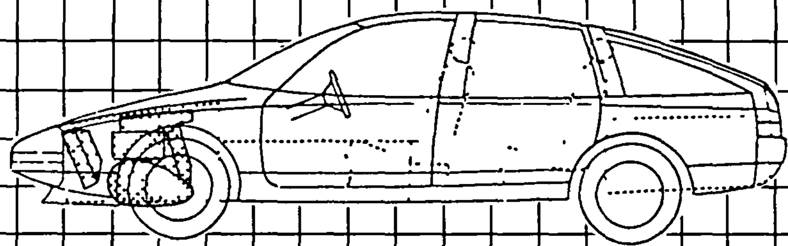
Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	15/33
Volume (l/cu ft)...............	7/0.2
Rated Power (kW)...............	20.8
Engine Transmission type.......	
Weight (kg/lb).................	
Volume (l/cm ft)...............	
Rated Power (kW)...............	

CALCULATED DATA

Range (km/mi)..................	130/81
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.12/0.20
Annual Energy (kWh)..........	1453
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	8104
Operating ($/km/mi)..........	0.16/0.26
Life Cycle ($/km/mi).........	0.15/0.24

100-mi DATA

160-km Baseline ICE
5-Passenger



VEHICLE DATA

Seating Capacity..........	5
Curb Weight (kg/lb).......	895/1969
Test Weight (kg/lb).......	1031/2268
Weight Dist. [f/r (%)]....	58/42
Wheelbase (in./cm)........	107/272
Length (in./cm)...........	184/467
Width (in./cm)............	70/178
Height (in./cm)...........	54/138
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	$500^{+}/17.6^{+}$
Fuel Capacity (gal/l).....	10/40

BATTERY

Name......................	
Weight (kg/lb)............	
Volume (l/cu ft)..........	

MOTOR

Type......................	
Weight (kg/lb)............	
Volume (l/cu ft)..........	
Rated Power (Cont. kW)....	

CONTROLLER

Type......................	
Weight (kg/lb)............	
Volume (l/cu ft)..........	
Rated Power (kW)..........	

ENGINE

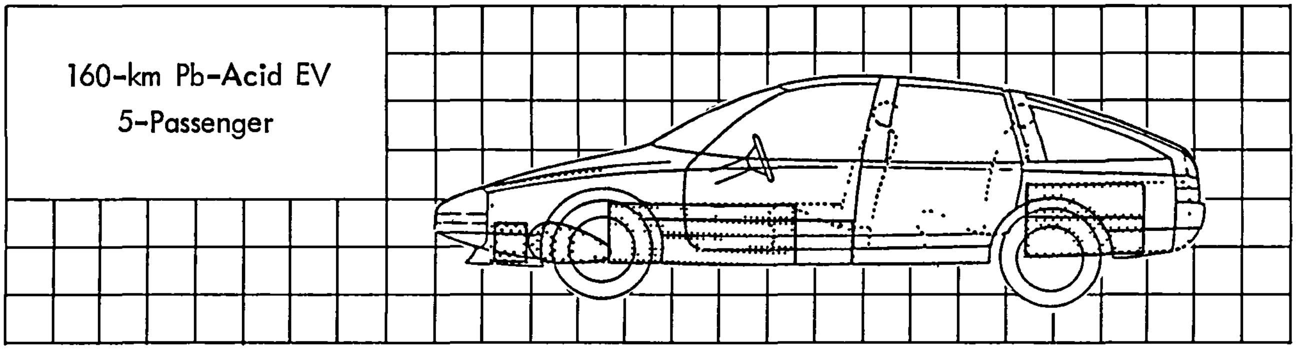
Type..........................	4 cyl-SI
Compression Ratio.............	12
Weight (kg/lb)................	64/141
Volume (l/cu ft)..............	16/0.6
Rated Power (kW)..............	31
Fuel..........................	Methanol

DRIVETRAIN

Motor Trans. Type..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Engine Transmission type.......	CVT
Weight (kg/lb).................	26/57
Volume (l/cm ft)...............	36/1.3
Rated Power (kw)...............	31

CALCULATED DATA

Range (km/mi)..................	400/250
Fuel Economy	
Electric Mode (kWh/km/mi)....	
Annual Energy (kWh)..........	
Heat Engine Mode (mpg).......	25
Annual fuel (l/g)............	1302/326
Cost - 1982$	
Initial......................	7210
Operating ($/km/mi)..........	0.16/0.26
Life Cycle ($/km/mi).........	0.16/0.26



VEHICLE DATA

Seating Capacity	5
Curb Weight (kg/lb)	1768/3890
Test Weight (kg/lb)	1904/4189
Weight Dist. [f/r (%)]	51/49
Wheelbase (in./cm)	107/272
Length (in./cm)	184/467
Width (in./cm)	70/178
Height (in./cm)	54/138
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	$500^{+}/17.6^{+}$
Fuel Capacity (gal/l)	

BATTERY

Name	Pb-Acid
Weight (kg/lb)	590/1298
Volume (l/cu ft)	281/9.9

MOTOR

Type	AC
Weight (kg/lb)	98/216
Volume (l/cu ft)	31/1.1
Rated Power (Cont. kW)	48

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	21/46
Volume (l/cu ft)	53/1.9
Rated Power (kW)	53

ENGINE

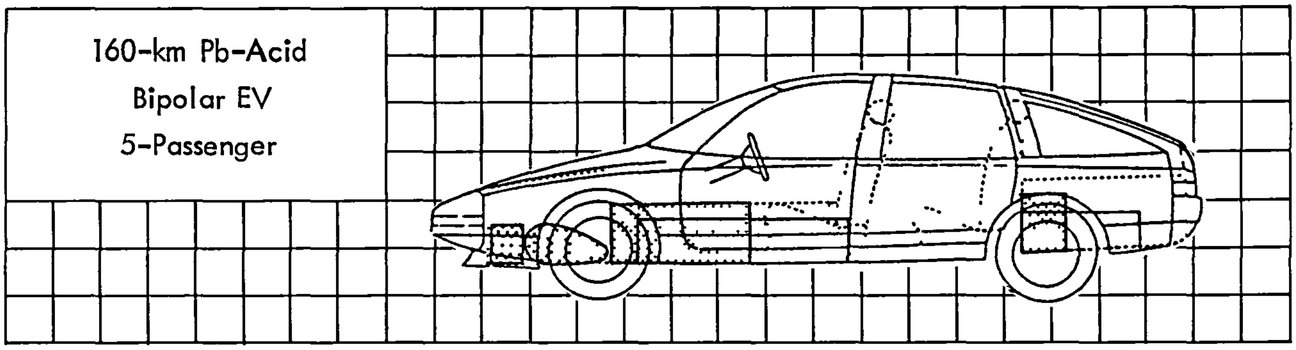
Type	
Displacement	
Compression Ratio	
Weight (kg/lb)	
Volume (l/cu ft)	
Rated Power (kW)	
Fuel	

DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	38/84
Volume (l/cu ft)	19/0.7
Rated Power (kW)	53
Engine Transmission type	
Weight (kg/lb)	
Volume (l/cm ft)	
Rated Power (kW)	

CALCULATED DATA

Range (km/mi)	158/99
Fuel Economy	
Electric Mode (kWh/km/mi)	0.21/0.33
Annual Energy (kWh)	2771
Heat Engine Mode (mpg)	
Annual Fuel (l/g)	
Cost - 1982$	
Initial	13752
Operating ($/km/mi)	0.17/0.27
Life Cycle ($/km/mi)	0.18/0.29



VEHICLE DATA

Seating Capacity..........	5
Curb Weight (kg/lb).......	1498/3296
Test Weight (kg/lb).......	1634/3595
Weight Dist. [f/r (%)]....	54/46
Wheelbase (in./cm)........	107/272
Length (in./cm)...........	184/467
Width (in./cm)............	70/178
Height (in./cm)...........	54/138
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	$500^{+}/17.6^{+}$
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Pb-Acid Bipolar
Weight (kg/lb)............	404/889
Volume (l/cu ft)..........	204/7.2

MOTOR

Type......................	AC
Weight (kg/lb)............	84/185
Volume (l/cu ft)..........	27/0.9
Rated Power (Cont. kW)....	41.2

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	18/40
Volume (l/cu ft)..........	45.7/1.6
Rated Power (kW)..........	45.7

ENGINE

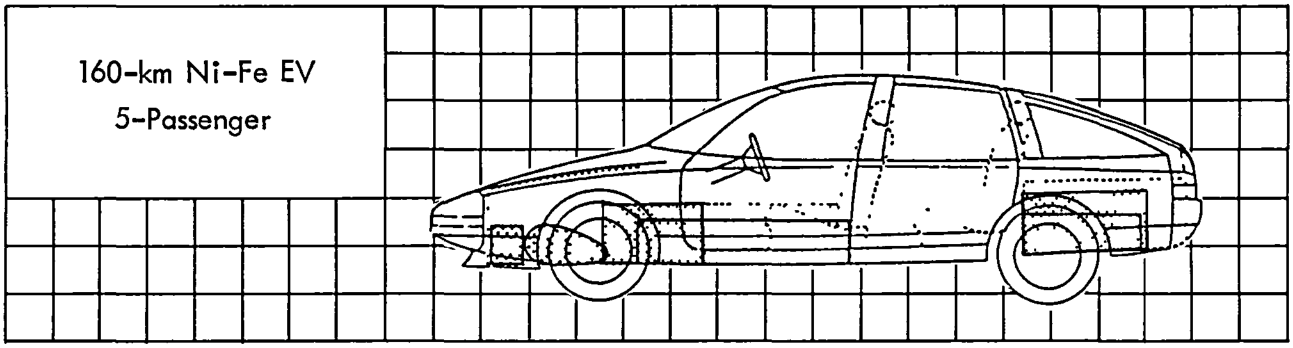
Type...........................	
Displacement...................	
Compression Ratio..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Fuel...........................	

DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	32/70
Volume (l/cu ft)...............	16/0.6
Rated Power (kW)...............	45.7
Engine Transmission type.......	
Weight (kg/lb).................	
Volume (l/cm ft)...............	
Rated Power (kW)...............	

CALCULATED DATA

Range (km/mi)..................	157/98
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.16/0.26
Annual Energy (kWh)..........	2128
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	12124
Operating ($/km/mi)..........	0.15/0.24
Life Cycle ($/km/mi).........	0.16/0.26



VEHICLE DATA

Seating Capacity..........	5
Curb Weight (kg/lb).......	1545/3399
Test Weight (kg/lb).......	1681/3698
Weight Dist. [f/r (%)]....	50/50
Wheelbase (in./cm)........	107/272
Length (in./cm)...........	184/467
Width (in./cm)............	70/178
Height (in./cm)...........	54/138
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	$500^{+}/17.6^{+}$
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Ni-Fe
Weight (kg/lb)............	437/961
Volume (l/cu ft)..........	261/9.2

MOTOR

Type......................	AC
Weight (kg/lb)............	86/189
Volume (l/cu ft)..........	28/1
Rated Power (Cont. kW)....	42.4

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	19/42
Volume (l/cu ft)..........	47/1.7
Rated Power (kW)..........	47

ENGINE

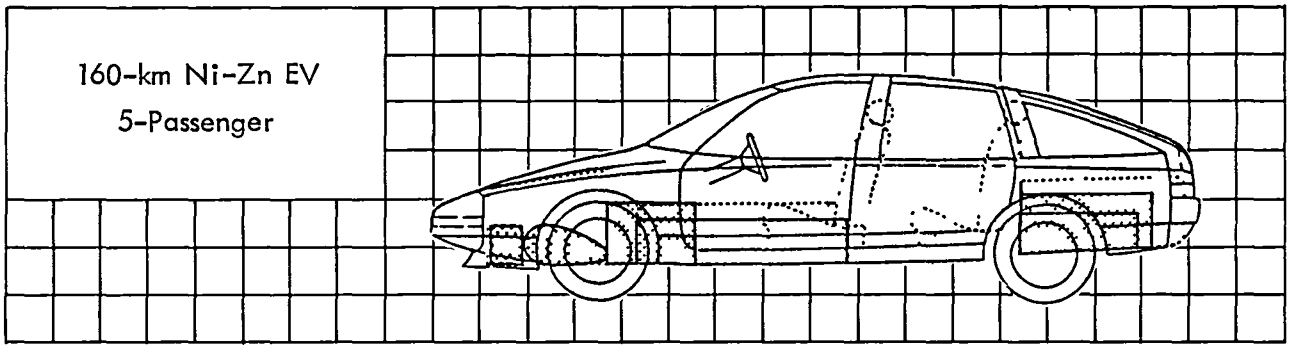
Type...........................	
Displacement...................	
Compression Ratio..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Fuel...........................	

DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	33/73
Volume (l/cu ft)...............	17/0.6
Rated Power (kW)...............	47
Engine Transmission type.......	
Weight (kg/lb).................	
Volume (l/cm ft)...............	
Rated Power (kW)...............	

CALCULATED DATA

Range (km/mi)..................	154/96
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.26/0.42
Annual Energy (kWh)..........	3480
Heat Engine Mode (mpg).......	
Annual Fuel (l/g)............	
Cost - 1982$	
Initial......................	14756
Operating ($/km/mi)..........	0.16/0.26
Life Cycle ($/km/mi).........	0.18/0.29



VEHICLE DATA

Seating Capacity..........	5
Curb Weight (kg/lb).......	1399/3078
Test Weight (kg/lb).......	1535/3377
Weight Dist. [f/r (%)]....	51/49
Wheelbase (in./cm)........	107/272
Length (in./cm)...........	184/467
Width (in./cm)............	70/178
Height (in./cm)...........	54/138
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	$500^+/17.6^+$
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Ni-Zn
Weight (kg/lb)............	336/739
Volume (l/cu ft)..........	202/7.1

MOTOR

Type......................	AC
Weight (kg/lb)............	79/174
Volume (l/cu ft)..........	25/0.9
Rated Power (Cont. kW)....	38.7

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	17/37
Volume (l/cu ft)..........	43/1.5
Rated Power (kW)..........	43

ENGINE

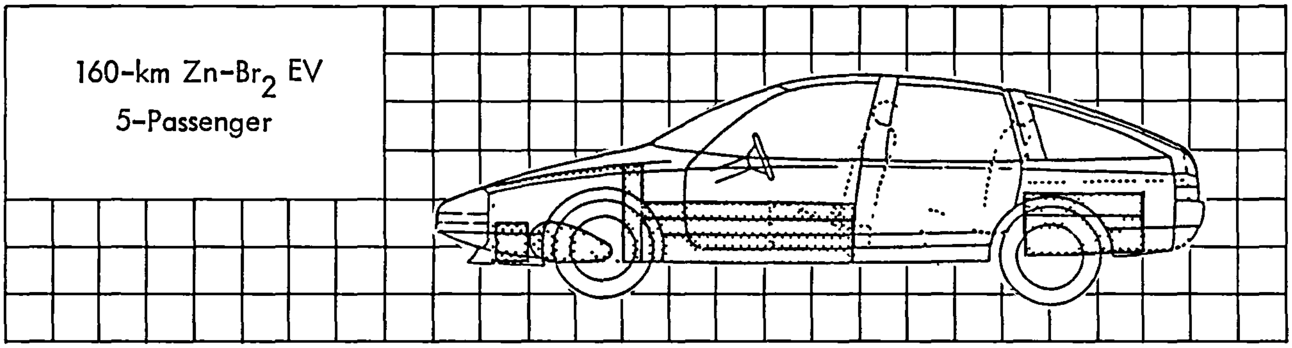
Type...........................	
Displacement...................	
Compression Ratio..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Fuel...........................	

DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	30/66
Volume (l/cu ft)...............	15/0.5
Rated Power (kW)...............	43
Engine Transmission type.......	
Weight (kg/lb).................	
Volume (l/cm ft)...............	
Rated Power (kW)...............	

CALCULATED DATA

Range (km/mi)..................	166/104
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.19/0.30
Annual Energy (kWh)..........	2546
Heat Engine Mode (mpg).......	
Annual Fuel (l/g)............	
Cost - 1982$	
Initial......................	13403
Operating ($/km/mi)..........	0.18/0.29
Life Cycle ($/km/mi).........	0.18/0.29



VEHICLE DATA

Seating Capacity..........	5
Curb Weight (kg/lb).......	1700/3740
Test Weight (kg/lb).......	1836/4039
Weight Dist. [f/r (%)]....	40/60
Wheelbase (in./cm)........	107/272
Length (in./cm)...........	184/467
Width (in./cm)............	70/178
Height (in./cm)...........	54/138
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	$500^{+}/17.6^{+}$
Fuel Capacity (gal/l).....	

BATTERY

Name......................	$Zn\text{-}Br_2$
Weight (kg/lb)............	544/1197
Volume (l/cu ft)..........	544/19.2

MOTOR

Type......................	AC
Weight (kg/lb)............	94/207
Volume (l/cu ft)..........	30/1.1
Rated Power (Cont. kW)....	46.3

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	21/46
Volume (l/cu ft)..........	51/1.8
Rated Power (kW)..........	51

ENGINE

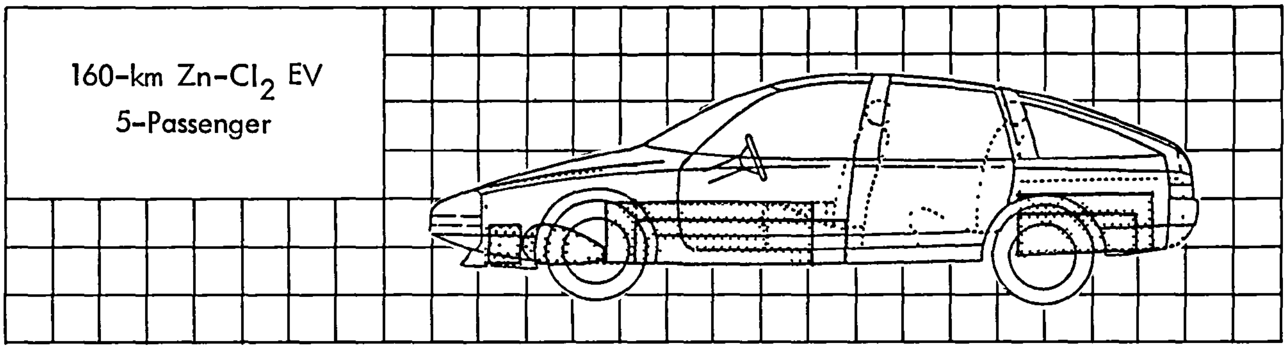
Type...........................	
Displacement...................	
Compression Ratio..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Fuel...........................	

DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	36/79
Volume (l/cu ft)...............	18/0.6
Rated Power (kW)...............	51.4
Engine Transmission type.......	
Weight (kg/lb).................	
Volume (l/cm ft)...............	
Rated Power (kW)...............	

CALCULATED DATA

Range (km/mi)..................	154/96
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.37/0.59
Annual Energy (kWh)..........	4843
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	13298
Operating ($/km/mi)..........	0.19/0.30
Life Cycle ($/km/mi).........	0.19/0.30



VEHICLE DATA

Seating Capacity..........	5
Curb Weight (kg/lb).......	1499/3298
Test Weight (kg/lb).......	1635/3597
Weight Dist. [f/r (%)]....	49/51
Wheelbase (in./cm)........	107/272
Length (in./cm)...........	184/467
Width (in./cm)............	70/178
Height (in./cm)...........	54/138
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	$500^+/17.6^+$
Fuel Capacity (gal/l).....	

BATTERY

Name......................	$Zn-Cl_2$
Weight (kg/lb)............	406/893
Volume (l/cu ft)..........	457/16.1

MOTOR

Type......................	AC
Weight (kg/lb)............	84/185
Volume (l/cu ft)..........	27/0.9
Rated Power (Cont. kW)....	41.2

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	18/40
Volume (l/cu ft)..........	46/1.6
Rated Power (kW)..........	45.8

ENGINE

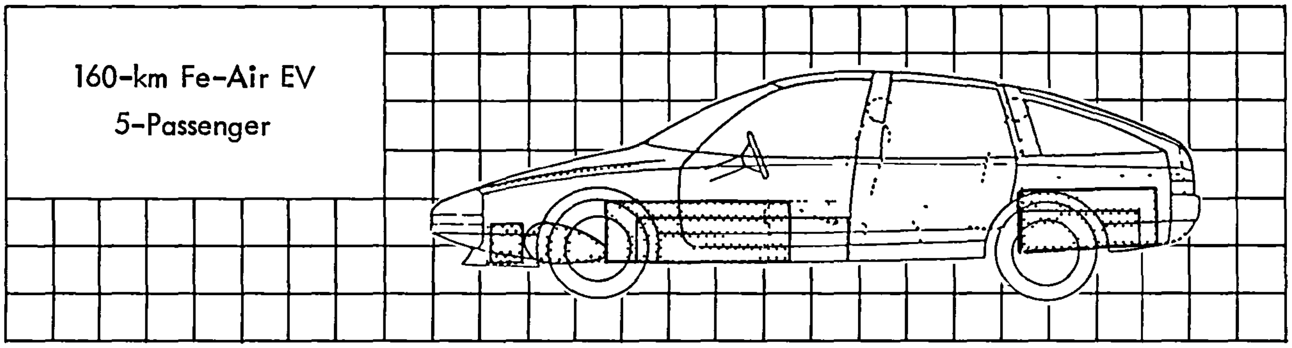
Type...........................	
Displacement...................	
Compression Ratio..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Fuel...........................	

DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	32/70
Volume (l/cu ft)...............	16/0.6
Rated Power (kW)...............	45.8
Engine Transmission type.......	
Weight (kg/lb).................	
Volume (l/cm ft)...............	
Rated Power (kW)...............	

CALCULATED DATA

Range (km/mi)..................	155/97
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.30/0.48
Annual Energy (kWh)..........	3909
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	14948
Operating ($/km/mi)..........	0.18/0.29
Life Cycle ($/km/mi).........	0.20/0.32



VEHICLE DATA

Seating Capacity	5
Curb Weight (kg/lb)	1401/3082
Test Weight (kg/lb)	1537/3381
Weight Dist. [f/r (%)]	52/48
Wheelbase (in./cm)	107/272
Length (in./cm)	184/467
Width (in./cm)	70/178
Height (in./cm)	54/138
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	$500^{+}/17.6^{+}$
Fuel Capacity (gal/l)	

BATTERY

Name	Fe-Air
Weight (kg/lb)	338/744
Volume (l/cu ft)	426/15.1

MOTOR

Type	AC
Weight (kg/lb)	79/174
Volume (l/cu ft)	25/0.9
Rated Power (Cont. kW)	38.7

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	17/37
Volume (l/cu ft)	43/1.5
Rated Power (kW)	43

ENGINE

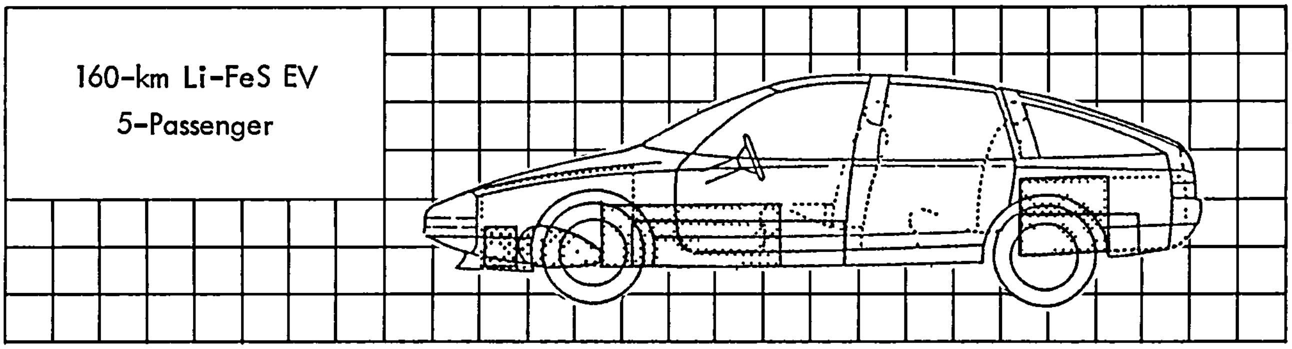
Type	
Displacement	
Compression Ratio	
Weight (kg/lb)	
Volume (l/cu ft)	
Rated Power (kW)	
Fuel	

DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	30/66
Volume (l/cu ft)	15/0.5
Rated Power (kW)	43
Engine Transmission type	
Weight (kg/lb)	
Volume (l/cm ft)	
Rated Power (kW)	

CALCULATED DATA

Range (km/mi)	154/96
Fuel Economy	
Electric Mode (kWh/km/mi)	0.33/0.53
Annual Energy (kWh)	4368
Heat Engine Mode (mpg)	
Annual Fuel (l/g)	
Cost - 1982$	
Initial	12594
Operating ($/km/mi)	0.21/0.34
Life Cycle ($/km/mi)	0.20/0.32



VEHICLE DATA

Seating Capacity	5
Curb Weight (kg/lb)	1369/3012
Test Weight (kg/lb)	1505/3311
Weight Dist. [f/r (%)]	55/45
Wheelbase (in./cm)	107/272
Length (in./cm)	184/467
Width (in./cm)	70/178
Height (in./cm)	54/138
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	$500^{+}/17.6^{+}$
Fuel Capacity (gal/l)	

BATTERY

Name	Li-FeS
Weight (kg/lb)	316/695
Volume (l/cu ft)	226/8.0

MOTOR

Type	AC
Weight (kg/lb)	77/169
Volume (l/cu ft)	25/0.9
Rated Power (Cont. kW)	37.9

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	17/37
Volume (l/cu ft)	42/1.5
Rated Power (kW)	42.1

ENGINE

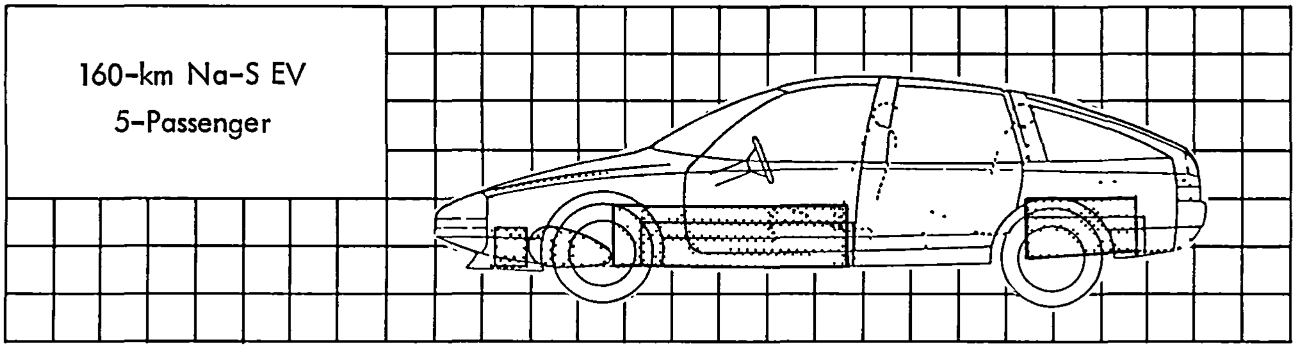
Type	
Displacement	
Compression Ratio	
Weight (kg/lb)	
Volume (l/cu ft)	
Rated Power (kW)	
Fuel	

DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	30/66
Volume (l/cu ft)	15/0.5
Rated Power (kW)	42.1
Engine Transmission type	
Weight (kg/lb)	
Volume (l/cm ft)	
Rated Power (kW)	

CALCULATED DATA

Range (km/mi)	166/104
Fuel Economy	
Electric Mode (kWh/km/mi)	0.23/0.36
Annual Energy (kWh)	2988
Heat Engine Mode (mpg)	
Annual fuel (l/g)	
Cost - 1982$	
Initial	13343
Operating ($/km/mi)	0.18/0.29
Life Cycle ($/km/mi)	0.17/0.27



VEHICLE DATA

Seating Capacity	5
Curb Weight (kg/lb)	1266/2785
Test Weight (kg/lb)	1402/3084
Weight Dist. [f/r (%)]	57/43
Wheelbase (in./cm)	107/272
Length (in./cm)	184/467
Width (in./cm)	70/178
Height (in./cm)	54/138
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	$500^+/17.6^+$
Fuel Capacity (gal/l)	

BATTERY

Name	Na-S
Weight (kg/lb)	245/539
Volume (l/cu ft)	271/9.6

MOTOR

Type	AC
Weight (kg/lb)	72/158
Volume (l/cu ft)	23/0.8
Rated Power (Cont. kW)	35.3

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	16/35
Volume (l/cu ft)	39/1.4
Rated Power (kW)	39.3

ENGINE

Type	
Displacement	
Compression Ratio	
Weight (kg/lb)	
Volume (l/cu ft)	
Rated Power (kW)	
Fuel	

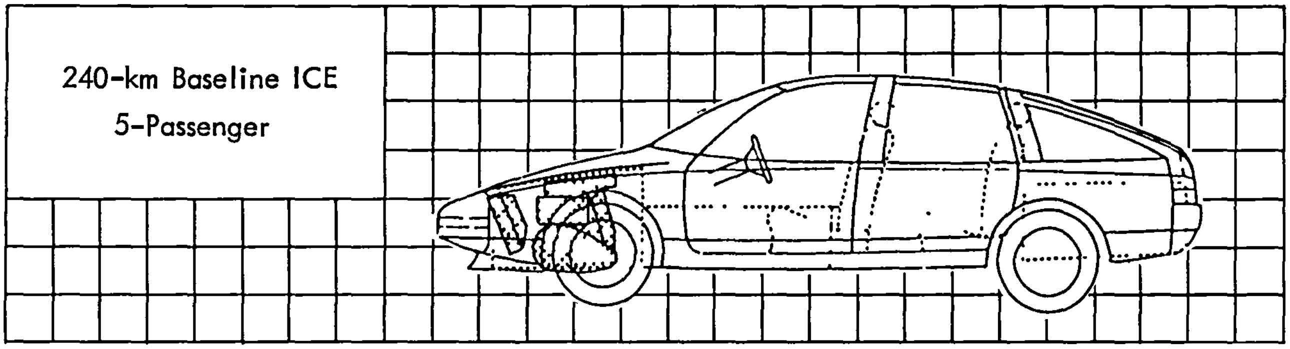
DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	28/62
Volume (l/cu ft)	14/0.5
Rated Power (kW)	39.3
Engine Transmission type	
Weight (kg/lb)	
Volume (l/cm ft)	
Rated Power (kW)	

CALCULATED DATA

Range (km/mi)	170/106
Fuel Economy	
Electric Mode (kWh/km/mi)	0.19/0.30
Annual Energy (kWh)	2550
Heat Engine Mode (mpg)	
Annual Fuel (l/g)	
Cost - 1982$	
Initial	14269
Operating ($/km/mi)	0.20/0.32
Life Cycle ($/km/mi)	0.19/0.30

150-mi DATA



VEHICLE DATA

Seating Capacity..........	5
Curb Weight (kg/lb).......	895/1969
Test Weight (kg/lb).......	1031/2268
Weight Dist. [f/r (%)]....	58/42
Wheelbase (in./cm)........	107/272
Length (in./cm)...........	184/467
Width (in./cm)............	70/178
Height (in./cm)...........	54/138
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	$500^{+}/17.6^{+}$
Fuel Capacity (gal/l).....	10/40

BATTERY

Name......................	
Weight (kg/lb)............	
Volume (l/cu ft)..........	

MOTOR

Type......................	
Weight (kg/lb)............	
Volume (l/cu ft)..........	
Rated Power (Cont. kW)....	

CONTROLLER

Type......................	
Weight (kg/lb)............	
Volume (l/cu ft)..........	
Rated Power (kW)..........	

ENGINE

Type...........................	4 cyl-SI
Displacement...................	2000cc/kW
Compression Ratio..............	12
Weight (kg/lb).................	64/141
Volume (l/cu ft)...............	16/0.6
Rated Power (kW)...............	31
Fuel...........................	Methanol

DRIVETRAIN

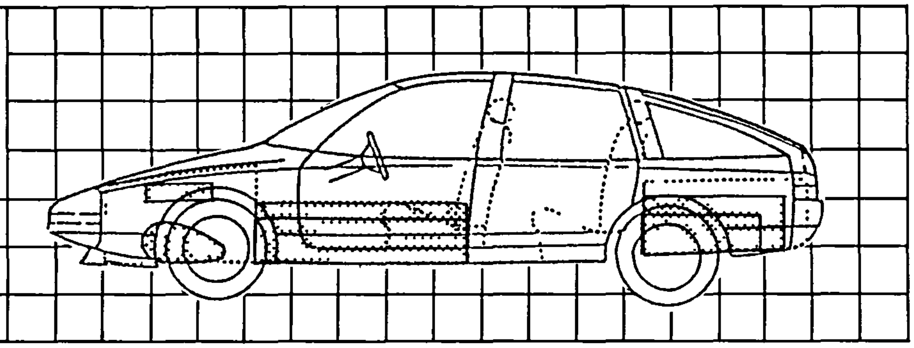
Motor Trans. Type..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Engine Transmission type.......	CVT
Weight (kg/lb).................	26/57
Volume (l/cm ft)...............	36/1.3
Rated Power (kW)...............	31

CALCULATED DATA

Range (km/mi)..................	400/250
Fuel Economy	
Electric Mode (kWh/km/mi)....	
Annual Energy (kWh)..........	
Heat Engine Mode (mpg).......	25
Annual fuel (l/g)............	1511/378
Cost - 1982$	
Initial......................	7210
Operating ($/km/mi)..........	0.15/0.24
Life Cycle ($/km/mi).........	0.15/0.24

240-km Pb-Acid EV

5-Passenger



VEHICLE DATA

Seating Capacity	5
Curb Weight (kg/lb)	2366/5205
Test Weight (kg/lb)	2502/5504
Weight Dist. [f/r (%)]	45/55
Wheelbase (in./cm)	107/272
Length (in./cm)	184/467
Width (in./cm)	70/178
Height (in./cm)	54/138
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	500^+/17.6^+
Fuel Capacity (gal/l)	

BATTERY

Name	Pb-Acid
Weight (kg/lb)	1001/2202
Volume (l/cu ft)	477/16.9

MOTOR

Type	AC
Weight (kg/lb)	129/284
Volume (l/cu ft)	41/1.4
Rated Power (Cont. kW)	63

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	28/62
Volume (l/cu ft)	70/2.5
Rated Power (kW)	70

ENGINE

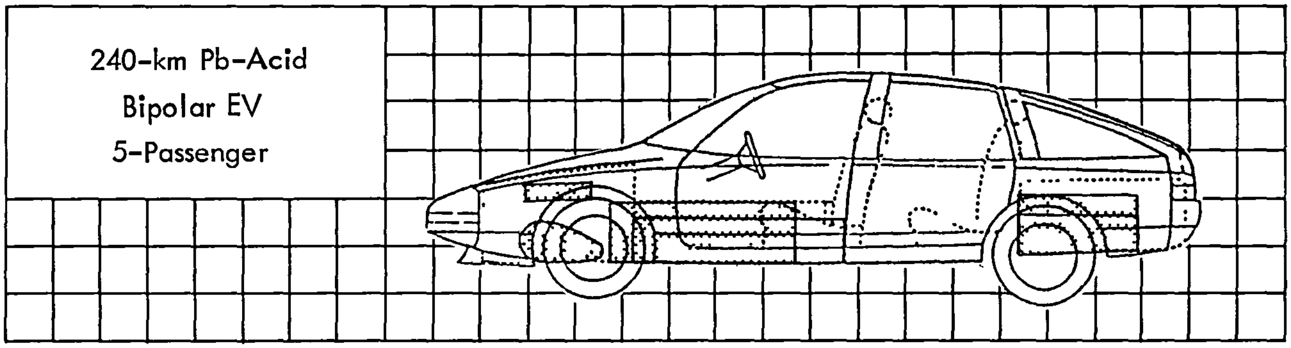
Type	
Displacement	
Compression Ratio	
Weight (kg/lb)	
Volume (l/cu ft)	
Rated Power (kW)	
Fuel	

DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	49/108
Volume (l/cu ft)	25/0.9
Rated Power (kW)	70
Engine Transmission type	
Weight (kg/lb)	
Volume (l/cm ft)	
Rated Power (kW)	

CALCULATED DATA

Range (km/mi)	235/147
Fuel Economy	
Electric Mode (kWh/km/mi)	0.26/0.41
Annual Energy (kWh)	3863
Heat Engine Mode (mpg)	
Annual Fuel (l/g)	
Cost - 1982$	
Initial	17483
Operating ($/km/mi)	0.19/0.30
Life Cycle ($/km/mi)	0.18/0.29



VEHICLE DATA

Seating Capacity..........	5
Curb Weight (kg/lb).......	2007/4415
Test Weight (kg/lb).......	2143/4715
Weight Dist. [f/r (%)]....	48/52
Wheelbase (in./cm)........	107/272
Length (in./cm)...........	184/467
Width (in./cm)............	70/178
Height (in./cm)...........	54/138
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	$500^{+}/17.6^{+}$
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Pb-Acid Bipolar
Weight (kg/lb)............	754/1659
Volume (l/cu ft)..........	381/13.5

MOTOR

Type......................	AC
Weight (kg/lb)............	110/242
Volume (l/cu ft)..........	35/1.2
Rated Power (Cont. kW)....	54

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	24/53
Volume (l/cu ft)..........	60/2.1
Rated Power (kW)..........	60

ENGINE

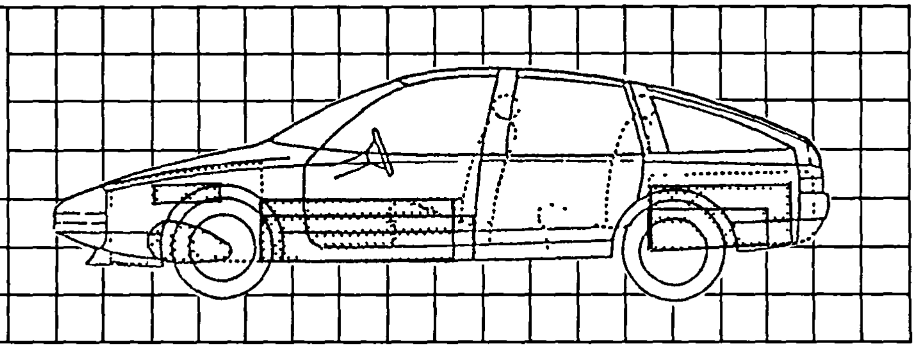
Type............................	
Displacement....................	
Compression Ratio...............	
Weight (kg/lb)..................	
Volume (l/cu ft)................	
Rated Power (kW)................	
Fuel............................	

DRIVETRAIN

Motor Trans. Type...............	Fixed Reduction
Weight (kg/lb)..................	42/92
Volume (l/cu ft)................	21/0.7
Rated Power (kW)................	60
Engine Transmission type.......	
Weight (kg/lb)..................	
Volume (l/cm ft)................	
Rated Power (kW)................	

CALCULATED DATA

Range (km/mi)...................	245/153
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.20/0.32
Annual Energy (kWh)..........	2950
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	15800
Operating ($/km/mi)..........	0.14/0.22
Life Cycle ($/km/mi).........	0.16/0.26



240-km Ni-Fe EV
5-Passenger

VEHICLE DATA

Seating Capacity..........	5
Curb Weight (kg/lb).......	1875/4125
Test Weight (kg/lb).......	2011/4424
Weight Dist. [f/r (%)]....	47/53
Wheelbase (in./cm)........	107/272
Length (in./cm)...........	184/467
Width (in./cm)............	70/178
Height (in./cm)...........	54/138
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	$500^{+}/17.6^{+}$
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Ni-Fe
Weight (kg/lb)............	664/1461
Volume (l/cu ft)..........	397/14.0

MOTOR

Type......................	AC
Weight (kg/lb)............	103/227
Volume (l/cu ft)..........	33/1.2
Rated Power (Cont. kW)....	50.7

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	23/51
Volume (l/cu ft)..........	56/2.0
Rated Power (kW)..........	56.3

ENGINE

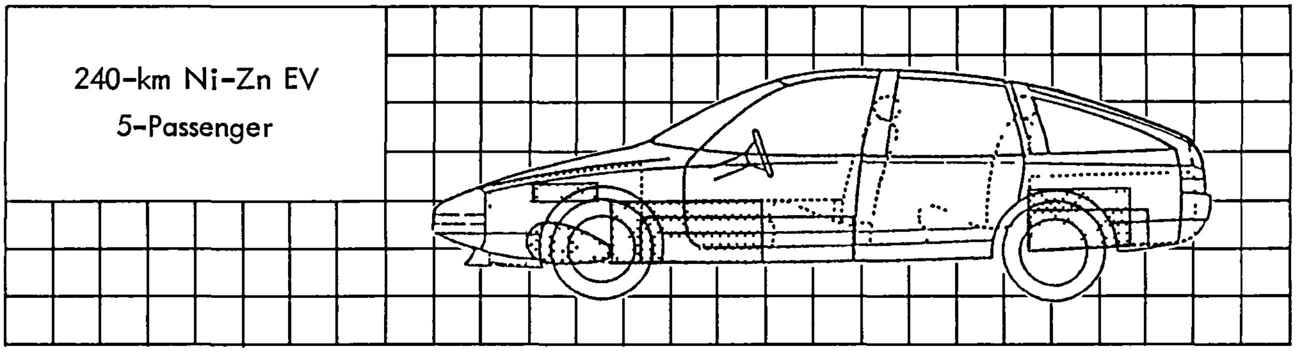
Type...........................	
Displacement...................	
Compression Ratio..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Fuel...........................	

DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	40/88
Volume (l/cu ft)...............	20/0.7
Rated Power (kW)...............	56.3
Engine Transmission type.......	
Weight (kg/lb).................	
Volume (l/cm ft)...............	
Rated Power (kW)...............	

CALCULATED DATA

Range (km/mi)..................	230/144
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.30/0.48
Annual Energy (kWh)..........	4520
Heat Engine Mode (mpg).......	
Annual Fuel (l/g)............	
Cost - 1982$	
Initial......................	17822
Operating ($/km/mi)..........	0.17/0.27
Life Cycle ($/km/mi).........	0.19/0.30



VEHICLE DATA

Seating Capacity..........	5
Curb Weight (kg/lb).......	1669/3672
Test Weight (kg/lb).......	1805/3971
Weight Dist. [f/r (%)]....	48/52
Wheelbase (in./cm)........	107/272
Length (in./cm)...........	184/467
Width (in./cm)............	70/178
Height (in./cm)...........	54/138
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	$500^+/17.6^+$
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Ni-Zn
Weight (kg/lb)............	522/1148
Volume (l/cu ft)..........	313/11.1

MOTOR

Type......................	AC
Weight (kg/lb)............	93/205
Volume (l/cu ft)..........	30/1.1
Rated Power (Cont. kW)....	45.5

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	20/44
Volume (l/cu ft)..........	51/1.8
Rated Power (kW)..........	50.5

ENGINE

Type..........................	
Displacement..................	
Compression Ratio.............	
Weight (kg/lb)................	
Volume (l/cu ft)..............	
Rated Power (kW)..............	
Fuel..........................	

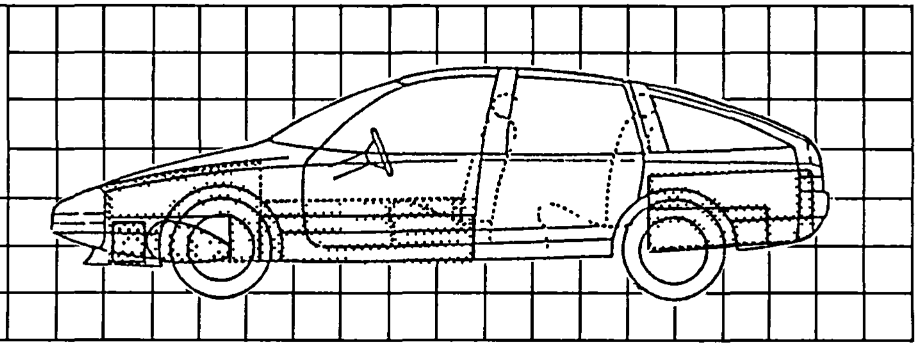
DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb)................	36/79
Volume (l/cu ft)..............	18/0.6
Rated Power (kW)..............	50.5
Engine Transmission type.......	
Weight (kg/lb)................	
Volume (l/cm ft)..............	
Rated Power (kW)..............	

CALCULATED DATA

Range ±5% (kg/mi)............	235/147
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.22/0.34
Annual Energy (kWh)..........	3243
Heat Engine Mode (mpg).......	
Annual Fuel (l/g)............	
Cost - 1982$	
Initial......................	15508
Operating ($/km/mi)..........	0.18/0.29
Life Cycle ($/km/mi).........	0.17/0.27

240-km $Zn\text{-}Br_2$ EV
5-Passenger



VEHICLE DATA

Seating Capacity..........	5
Curb Weight (kg/lb).......	2366/5205
Test Weight (kg/lb).......	2502/5504
Weight Dist. [f/r (%)]....	55/45
Wheelbase (in./cm)........	107/272
Length (in./cm)...........	184/467
Width (in./cm)............	70/178
Height (in./cm)...........	54/138
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	$500^+/17.6^+$
Fuel Capacity (gal/l).....	

BATTERY

Name......................	$Zn\text{-}Br_2$
Weight (kg/lb)............	1001/2002
Volume (l/cu ft)..........	863/30.5

MOTOR

Type......................	AC
Weight (kg/lb)............	129/284
Volume (l/cu ft)..........	41/1.5
Rated Power (Cont. kW)....	63

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	28/62
Volume (l/cu ft)..........	70/2.5
Rated Power (kW)..........	70.1

ENGINE

Type...........................	
Displacement...................	
Compression Ratio..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Fuel...........................	

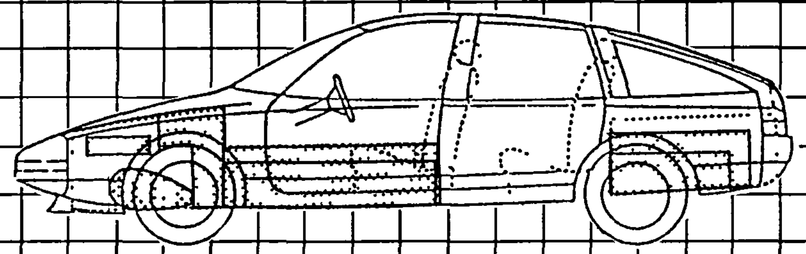
DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	49/108
Volume (l/cu ft)...............	25/0.9
Rated Power (kW)...............	70
Engine Transmission type.......	
Weight (kg/lb).................	
Volume (l/cm ft)...............	
Rated Power (kW)...............	

CALCULATED DATA

Range (km/mi)..................	232/145
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.50/0.79
Annual Energy (kWh)..........	7464
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	17068
Operating ($/km/mi)..........	0.21/0.34
Life Cycle ($/km/mi).........	0.21/0.34

240-km $Zn-Cl_2$ EV
5-Passenger



VEHICLE DATA

Seating Capacity	5
Curb Weight (kg/lb)	1995/4389
Test Weight (kg/lb)	2131/4688
Weight Dist. [f/r (%)]	55/45
Wheelbase (in./cm)	107/272
Length (in./cm)	184/467
Width (in./cm)	70/178
Height (in./cm)	54/138
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	500+/17.6+
Fuel Capacity (gal/l)	

BATTERY

Name	$Zn-Cl_2$
Weight (kg/lb)	746/1641
Volume (l/cu ft)	643/22.7

MOTOR

Type	AC
Weight (kg/lb)	110/242
Volume (l/cu ft)	35/1.2
Rated Power (Cont. kW)	53.7

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	24/53
Volume (l/cu ft)	60/2.1
Rated Power (kW)	59.7

ENGINE

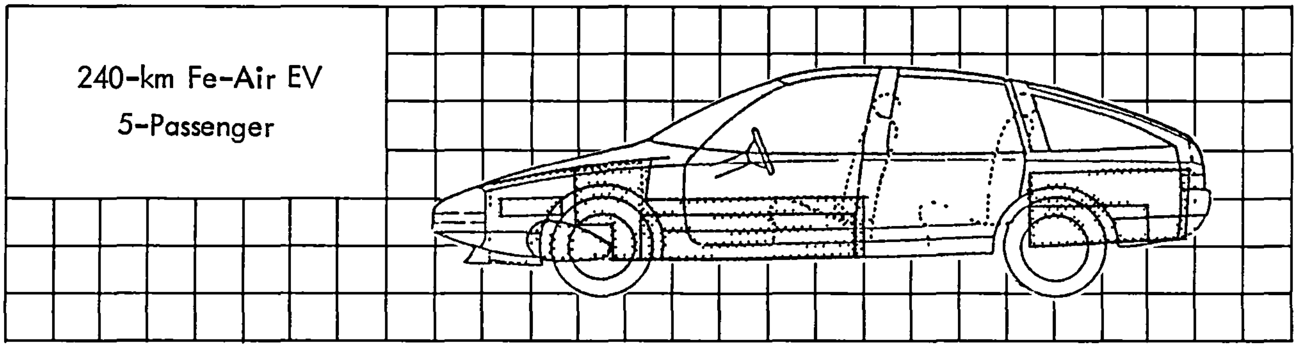
Type	
Displacement	
Compression Ratio	
Weight (kg/lb)	
Volume (l/cu ft)	
Rated Power (kW)	
Fuel	

DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	42/92
Volume (l/cu ft)	21/0.7
Rated Power (kW)	60
Engine Transmission type	
Weight (kg/lb)	
Volume (l/cm ft)	
Rated Power (kW)	

CALCULATED DATA

Range (km/mi)	237/148
Fuel Economy	
Electric Mode (kWh/km/mi)	0.37/0.58
Annual Energy (kWh)	5530
Heat Engine Mode (mpg)	
Annual fuel (l/g)	
Cost - 1982$	
Initial	19576
Operating ($/km/mi)	0.19/0.30
Life Cycle ($/km/mi)	0.22/0.35



VEHICLE DATA

Seating Capacity	5
Curb Weight (kg/lb)	1933/4253
Test Weight (kg/lb)	2069/4552
Weight Dist. [f/r (%)]	48/52
Wheelbase (in./cm)	107/272
Length (in./cm)	184/467
Width (in./cm)	70/178
Height (in./cm)	54/138
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	$500^+/17.6^+$
Fuel Capacity (gal/l)	

BATTERY

Name	Fe-Air
Weight (kg/lb)	704/1549
Volume (l/cu ft)	640/22.6

MOTOR

Type	AC
Weight (kg/lb)	106/233
Volume (l/cu ft)	34/1.2
Rated Power (Cont. kW)	52.1

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	23/51
Volume (l/cu ft)	58/2.0
Rated Power (kW)	57.9

ENGINE

Type	
Displacement	
Compression Ratio	
Weight (kg/lb)	
Volume (l/cu ft)	
Rated Power (kW)	
Fuel	

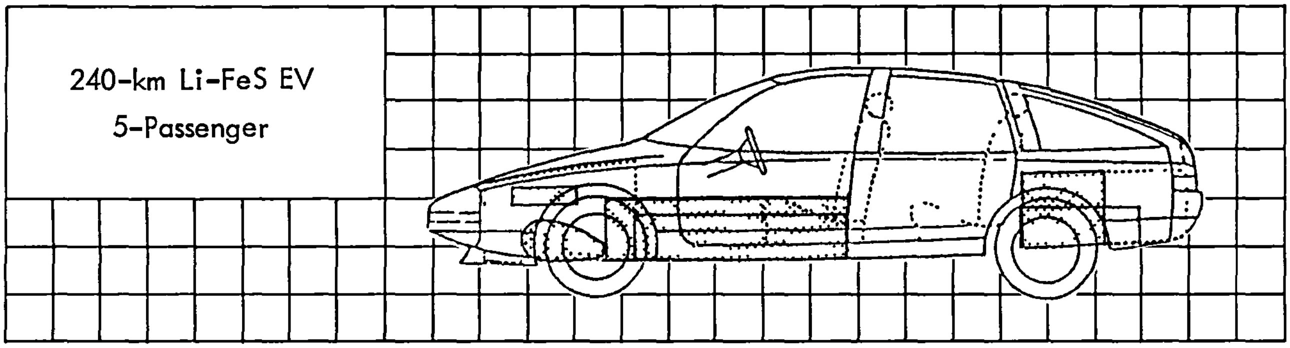
DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	41/90
Volume (l/cu ft)	21/0.7
Rated Power (kW)	57.9
Engine Transmission type	
Weight (kg/lb)	
Volume (l/cm ft)	
Rated Power (kW)	

CALCULATED DATA

Range (km/mi)	245/153
Fuel Economy	
Electric Mode (kWh/km/mi)	0.44/0.71
Annual Energy (kWh)	6675
Heat Engine Mode (mpg)	
Annual Fuel (l/g)	
Cost - 1982$	
Initial	16668
Operating ($/km/mi)	0.21/0.34
Life Cycle ($/km/mi)	0.22/0.34

240-km Li-FeS EV
5-Passenger



VEHICLE DATA

Seating Capacity	5
Curb Weight (kg/lb)	1565/3443
Test Weight (kg/lb)	1701/3742
Weight Dist. [f/r (%)]	53/47
Wheelbase (in./cm)	107/272
Length (in./cm)	184/467
Width (in./cm)	70/178
Height (in./cm)	54/138
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	$500^{+}/17.6^{+}$
Fuel Capacity (gal/l)	

BATTERY

Name	Li-FeS
Weight (kg/lb)	451/992
Volume (l/cu ft)	322/11.4

MOTOR

Type	AC
Weight (kg/lb)	87/191
Volume (l/cu ft)	28/1.0
Rated Power (Cont. kW)	42.9

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	19/42
Volume (l/cu ft)	48/1.7
Rated Power (kW)	47.6

ENGINE

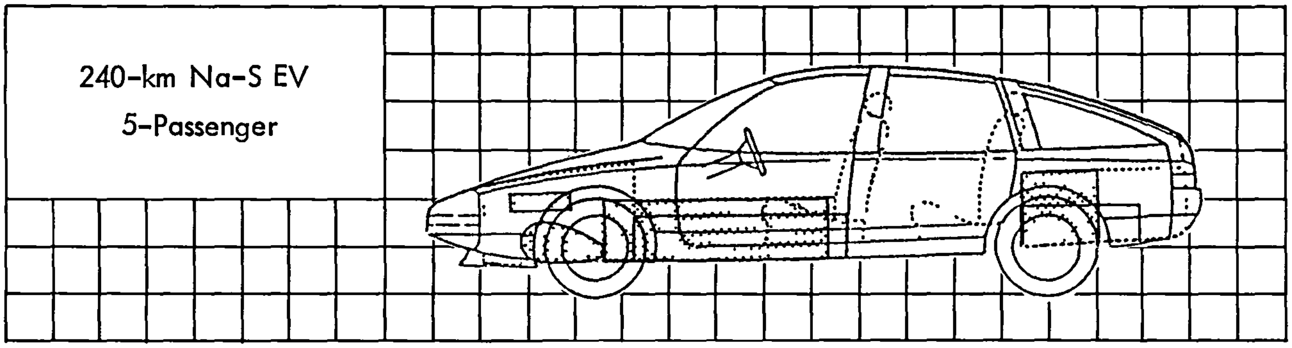
Type	
Displacement	
Compression Ratio	
Weight (kg/lb)	
Volume (l/cu ft)	
Rated Power (kW)	
Fuel	

DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	34/75
Volume (l/cu ft)	17/0.6
Rated Power (kW)	47.6
Engine Transmission type	
Weight (kg/lb)	
Volume (l/cm ft)	
Rated Power (kW)	

CALCULATED DATA

Range (km/mi)	250/156
Fuel Economy	
Electric Mode (kWh/km/mi)	0.25/0.39
Annual Energy (kWh)	3691
Heat Engine Mode (mpg)	
Annual fuel (l/g)	
Cost - 1982$	
Initial	15241
Operating ($/km/mi)	0.15/0.24
Life Cycle ($/km/mi)	0.17/0.27



VEHICLE DATA

Seating Capacity	5
Curb Weight (kg/lb)	1421/3126
Test Weight (kg/lb)	1557/3425
Weight Dist. [f/r (%)]	54/46
Wheelbase (in./cm)	107/272
Length (in./cm)	184/467
Width (in./cm)	70/178
Height (in./cm)	54/138
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	$500^+/17.6^+$
Fuel Capacity (gal/l)	

BATTERY

Name	Na-S
Weight (kg/lb)	352/774
Volume (l/cu ft)	390/13.8

MOTOR

Type	AC
Weight (kg/lb)	80/176
Volume (l/cu ft)	25/0.9
Rated Power (Cont. kW)	39.2

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	17/37
Volume (l/cu ft)	44/1.6
Rated Power (kW)	43.6

ENGINE

Type	
Displacement	
Compression Ratio	
Weight (kg/lb)	
Volume (l/cu ft)	
Rated Power (kW)	
Fuel	

DRIVETRAIN

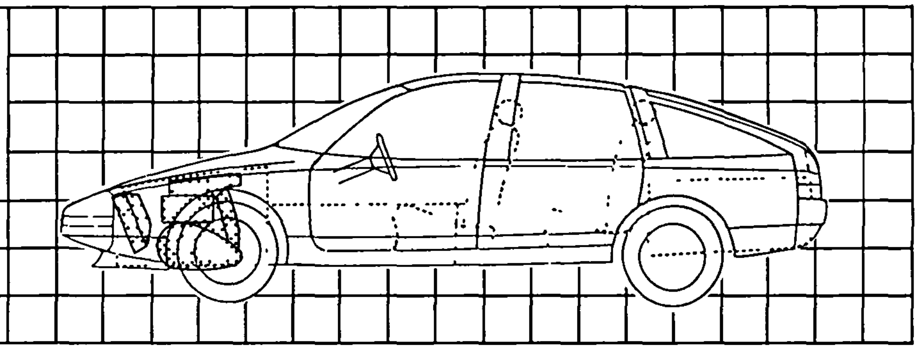
Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	31/68
Volume (l/cu ft)	16/0.6
Rated Power (kW)	43.6
Engine Transmission type	
Weight (kg/lb)	
Volume (l/cm ft)	
Rated Power (kW)	

CALCULATED DATA

Range (km/mi)	232/145
Fuel Economy	
Electric Mode (kWh/km/mi)	0.21/0.33
Annual Energy (kWh)	3108
Heat Engine Mode (mpg)	
Annual Fuel (l/g)	
Cost - 1982$	
Initial	13849
Operating ($/km/mi)	0.17/0.27
Life Cycle ($/km/mi)	0.16/0.26

250-mi DATA

400-km Baseline ICE
5-Passenger



VEHICLE DATA

Seating Capacity..........	5
Curb Weight (kg/lb).......	895/1969
Test Weight (kg/lb).......	1031/2268
Weight Dist. [f/r (%)]....	58/42
Wheelbase (in./cm)........	107/272
Length (in./cm)...........	184/467
Width (in./cm)............	70/178
Height (in./cm)...........	54/138
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	$500^+/17.6^+$
Fuel Capacity (gal/l).....	10/40

BATTERY

Name......................	
Weight (kg/lb)............	
Volume (l/cu ft)..........	

MOTOR

Type......................	
Weight (kg/lb)............	
Volume (l/cu ft)..........	
Rated Power (Cont. kW)....	

CONTROLLER

Type......................	
Weight (kg/lb)............	
Volume (l/cu ft)..........	
Rated Power (kW)..........	

ENGINE

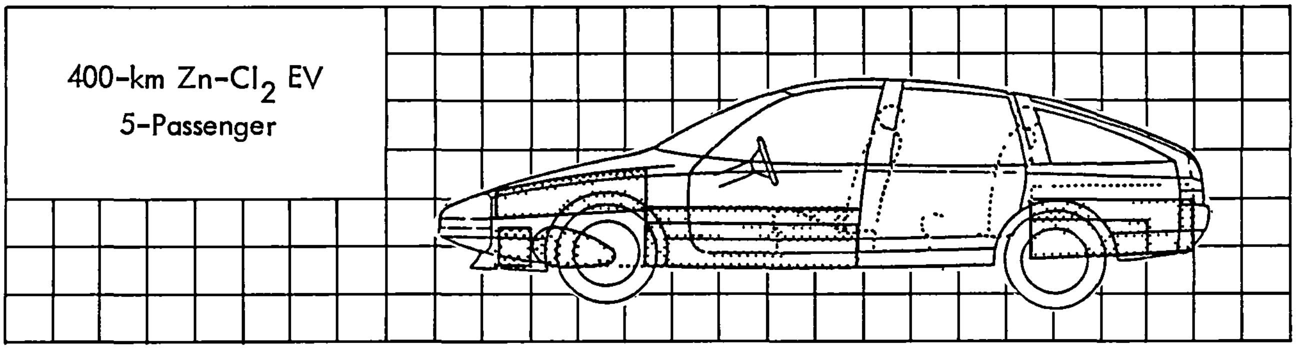
Type...........................	4 cyl-SI
Displacement...................	2000cc/kW
Compression Ratio..............	12
Weight (kg/lb).................	64/141
Volume (l/cu ft)...............	16/0.6
Rated Power (kW)...............	31
Fuel...........................	Methanol

DRIVETRAIN

Motor Trans. Type..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Engine Transmission type.......	CVT
Weight (kg/lb).................	26/57
Volume (l/cm ft)...............	36/1.3
Rated Power (kW)...............	31

CALCULATED DATA

Range (km/mi)..................	448/280
Fuel Economy	
Electric Mode (kWh/km/mi)....	
Annual Energy (kWh)..........	
Heat Engine Mode (mpg).......	28
Annual fuel (l/g)............	1610/403
Cost - 1982$	
Initial......................	7210
Operating ($/km/mi)..........	0.14/0.22
Life Cycle ($/km/mi).........	0.14/0.22



VEHICLE DATA

Seating Capacity..........	5
Curb Weight (kg/lb).......	2203/4846
Test Weight (kg/lb).......	2339/5146
Weight Dist. [f/r (%)]....	53/47
Wheelbase (in./cm)........	107/272
Length (in./cm)...........	184/467
Width (in./cm)............	70/178
Height (in./cm)...........	54/138
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	$500^+/17.6^+$
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Zn-Cl_2
Weight (kg/lb)............	889/1956
Volume (l/cu ft)..........	713/25.2

MOTOR

Type......................	AC
Weight (kg/lb)............	120/264
Volume (l/cu ft)..........	38/1.3
Rated Power (Cont. kW)....	58.9

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	26/57
Volume (l/cu ft)..........	66/2.3
Rated Power (kW)..........	65.5

ENGINE

Type...........................	
Displacement...................	
Compression Ratio..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Fuel...........................	

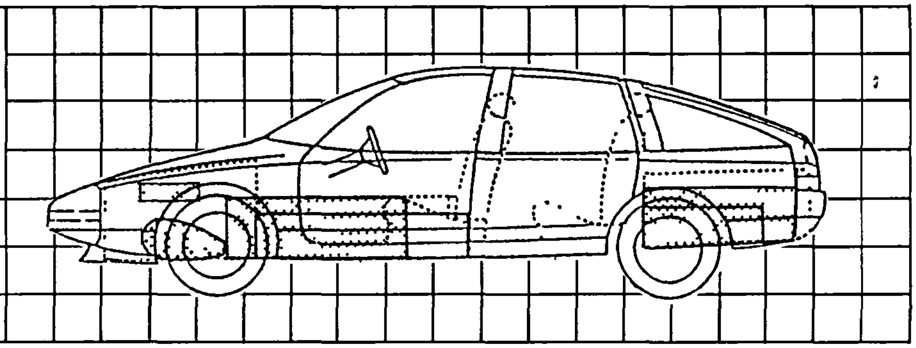
DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	46/101
Volume (l/cu ft)...............	23/0.8
Rated Power (kW)...............	65.5
Engine Transmission type.......	
Weight (kg/lb).................	
Volume (l/cm ft)...............	
Rated Power (kW)...............	

CALCULATED DATA

Range (km/mi)..................	419/262
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.39/0.63
Annual Energy (kWh)..........	6548
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	19704
Operating ($/km/mi)..........	0.18/0.29
Life Cycle ($/km/mi).........	0.20/0.32

400-km Fe-Air EV
5-Passenger



VEHICLE DATA

Seating Capacity	5
Curb Weight (kg/lb)	1963/4319
Test Weight (kg/lb)	2099/4618
Weight Dist. [f/r (%)]	45/55
Wheelbase (in./cm)	107/272
Length (in./cm)	184/467
Width (in./cm)	70/178
Height (in./cm)	54/138
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	$500^{+}/17.6^{+}$
Fuel Capacity (gal/l)	

BATTERY

Name	Fe-Air
Weight (kg/lb)	724/1593
Volume (l/cu ft)	533/18.8

MOTOR

Type	AC
Weight (kg/lb)	108/238
Volume (l/cu ft)	34/1.2
Rated Power (Cont. kW)	52.9

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	24/53
Volume (l/cu ft)	59/2.1
Rated Power (kW)	58.8

ENGINE

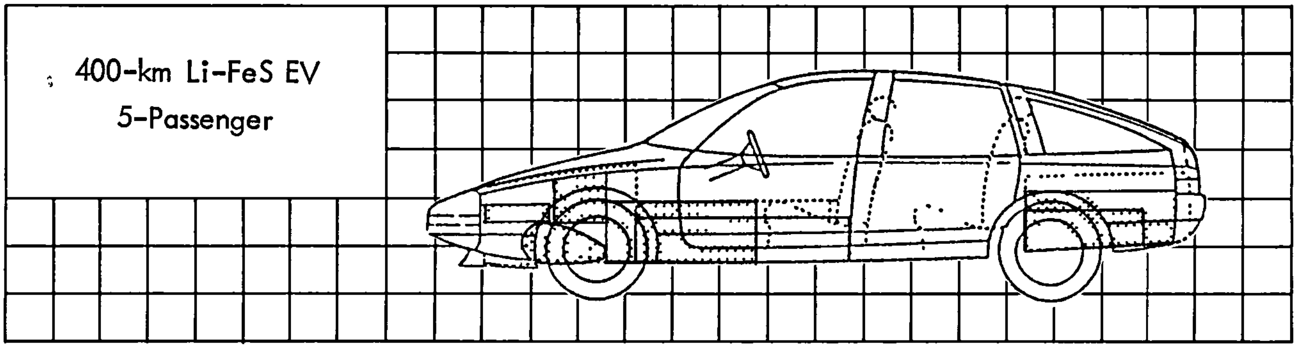
Type	
Displacement	
Compression Ratio	
Weight (kg/lb)	
Volume (l/cu ft)	
Rated Power (kW)	
Fuel	

DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	41/90
Volume (l/cu ft)	21/0.7
Rated Power (kW)	58.8
Engine Transmission type	
Weight (kg/lb)	
Volume (l/cm ft)	
Rated Power (kW)	

CALCULATED DATA

Range (km/mi)	395/247
Fuel Economy	
Electric Mode (kWh/km/mi)	0.44/0.7
Annual Energy (kWh)	7350
Heat Engine Mode (mpg)	
Annual Fuel (l/g)	
Cost - 1982$	
Initial	16064
Operating ($/km/mi)	0.16/0.26
Life Cycle ($/km/mi)	0.18/0.29



VEHICLE DATA

Seating Capacity	5
Curb Weight (kg/lb)	1804/3969
Test Weight (kg/lb)	1940/4268
Weight Dist. [f/r (%)]	48/52
Wheelbase (in./cm)	107/272
Length (in./cm)	184/467
Width (in./cm)	70/178
Height (in./cm)	54/138
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	$500^{+}/17.6^{+}$
Fuel Capacity (gal/l)	

BATTERY

Name	Li-FeS
Weight (kg/lb)	615/1353
Volume (l/cu ft)	439/15.5

MOTOR

Type	AC
Weight (kg/lb)	100/220
Volume (l/cu ft)	32/1.1
Rated Power (Cont. kW)	48.9

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	22/48
Volume (l/cu ft)	54/1.9
Rated Power (kW)	54.3

ENGINE

Type	
Displacement	
Compression Ratio	
Weight (kg/lb)	
Volume (l/cu ft)	
Rated Power (kW)	
Fuel	

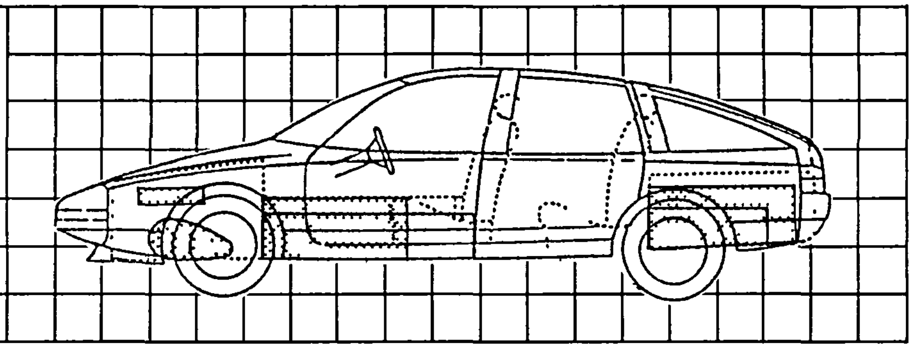
DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	38/84
Volume (l/cu ft)	19/0.7
Rated Power (kW)	54.3
Engine Transmission type	
Weight (kg/lb)	
Volume (l/cm ft)	
Rated Power (kW)	

CALCULATED DATA

Range (km/mi)	410/256
Fuel Economy	
Electric Mode (kWh/km/mi)	0.27/0.43
Annual Energy (kWh)	4480
Heat Engine Mode (mpg)	
Annual Fuel (l/g)	
Cost - 1982$	
Initial	19339
Operating ($/km/mi)	0.16/0.26
Life Cycle ($/km/mi)	0.18/0.29

400-km Na-S EV
5-Passenger



VEHICLE DATA

Seating Capacity	5
Curb Weight (kg/lb)	1545/3399
Test Weight (kg/lb)	1681/3698
Weight Dist. [f/r (%)]	51/49
Wheelbase (in./cm)	107/272
Length (in./cm)	184/467
Width (in./cm)	70/178
Height (in./cm)	54/138
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	$500^+/17.6^+$
Fuel Capacity (gal/l)	

BATTERY

Name	Na-S
Weight (kg/lb)	437/961
Volume (l/cu ft)	398/14

MOTOR

Type	AC
Weight (kg/lb)	86/189
Volume (l/cu ft)	28/1.0
Rated Power (Cont. kW)	42.4

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	19/42
Volume (l/cu ft)	22/0.8
Rated Power (kW)	47.1

ENGINE

Type	
Displacement	
Compression Ratio	
Weight (kg/lb)	
Volume (l/cu ft)	
Rated Power (kW)	
Fuel	

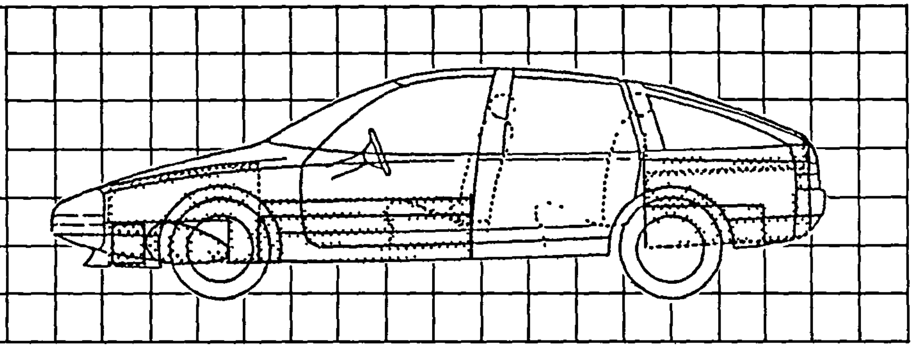
DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	33/73
Volume (l/cu ft)	17/0.6
Rated Power (kW)	47.1
Engine Transmission type	
Weight (kg/lb)	
Volume (l/cm ft)	
Rated Power (kW)	

CALCULATED DATA

Range (km/mi)	397/248
Fuel Economy	
Electric Mode (kWh/km/mi)	0.22/0.35
Annual Energy (kWh)	3616
Heat Engine Mode (mpg)	
Annual fuel (l/g)	
Cost - 1982$	
Initial	18267
Operating ($/km/mi)	0.16/0.26
Life Cycle ($/km/mi)	0.18/0.29

400-km Al-Air EV
5-Passenger



VEHICLE DATA

Seating Capacity..........	5
Curb Weight (kg/lb).......	1995/4389
Test Weight (kg/lb).......	2131/4688
Weight Dist. [f/r (%)]....	48/52
Wheelbase (in./cm)........	107/272
Length (in./cm)...........	184/467
Width (in./cm)............	70/178
Height (in./cm)...........	54/138
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	300/10.6
Fuel Capacity (gal/l).....	

BATTERY

Name......................	Al-Air
Weight (kg/lb)............	746/1641
Volume (l/cu ft)..........	837/29.5[1]

MOTOR

Type......................	AC
Weight (kg/lb)............	110/242
Volume (l/cu ft)..........	35/1.2
Rated Power (Cont. kW)....	53.7

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	24/53
Volume (l/cu ft)..........	60/2.1
Rated Power (kW)..........	59.7

ENGINE

Type...........................	
Displacement...................	
Compression Ratio..............	
Weight (kg/lb).................	
Volume (l/cu ft)...............	
Rated Power (kW)...............	
Fuel...........................	

DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	42/92
Volume (l/cu ft)...............	21/0.7
Rated Power (kW)...............	59.7
Engine Transmission type.......	
Weight (kg/lb).................	
Volume (l/cm ft)...............	
Rated Power (kW)...............	

CALCULATED DATA

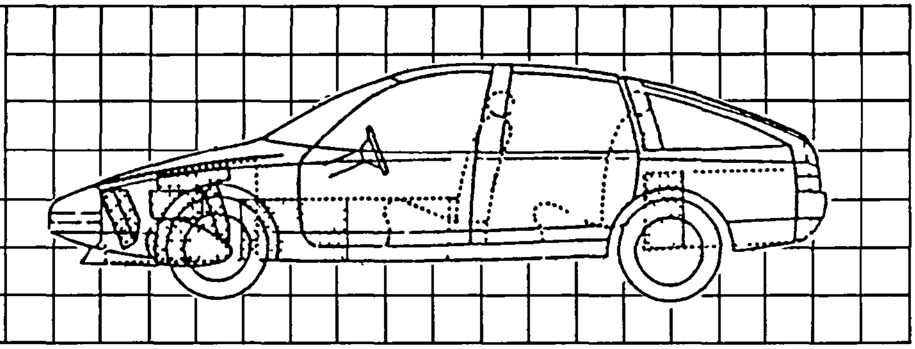
Range (km/mi)..................	
Fuel Economy	
Electric Mode (kWh/km/mi)....	1.5/2.39
Annual Energy (kWh)..........	24842
Heat Engine Mode (mpg).......	
Annual fuel (l/g)............	
Cost - 1982$	
Initial......................	18353
Operating ($/km/mi)..........	0.26/0.42
Life Cycle ($/km/mi).........	0.28/0.45

[1]Requires mass density to be increased to 0.9 kg/l; requires 1245 l with 0.6 kg/l.

HYBRID AND FUEL-CELL

VEHICLE DATA

400-km Pb-Acid Hyb
5-Passenger



VEHICLE DATA

Seating Capacity	5
Curb Weight (kg/lb)	1747/3843
Test Weight (kg/lb)	1883/4143
Weight Dist. [f/r (%)]	60/40
Wheelbase (in./cm)	107/272
Length (in./cm)	184/467
Width (in./cm)	70/178
Height (in./cm)	54/138
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	$500^{+}/17.6^{+}$
Fuel Capacity (gal/l)	10/40

BATTERY

Name	Pb-Acid
Weight (kg/lb)	411/904
Volume (l/cu ft)	174/6.1

MOTOR

Type	AC
Weight (kg/lb)	97/213
Volume (l/cu ft)	31/1.1
Rated Power (Cont. kW)	47.5

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	21/46
Volume (l/cu ft)	53/1.9
Rated Power (kW)	52.7

ENGINE

Type	4 cyl-SI
Displacement	2000cc/kW
Compression Ratio	12
Weight (kg/lb)	117/257
Volume (l/cu ft)	105/3.7
Rated Power (kW)	52.7
Fuel	Methanol

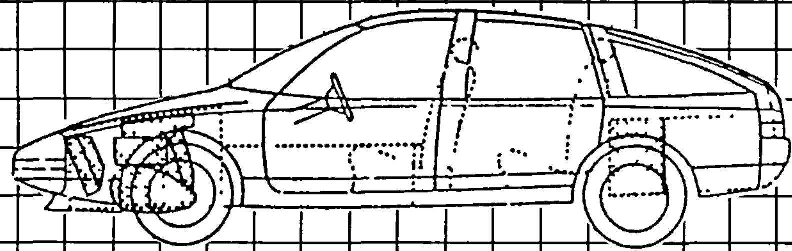
DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	37/81
Volume (l/cu ft)	19/0.7
Rated Power (kW)	52.7
Engine Transmission type	CVT
Weight (kg/lb)	48/106
Volume (l/cm ft)	62/2.2
Rated Power (kW)	52.7

CALCULATED DATA

Range (km/mi)	80/50 electric 352/220 engine
Fuel Economy	
Electric Mode (kWh/km/mi)	0.21/0.34
Annual Energy (kWh)	2635
Heat Engine Mode (mpg)	22
Annual fuel (l/g)	486/122
Cost - 1982$	
Initial	14871
Operating ($/km/mi)	0.18/0.29
Life Cycle ($/km/mi)	0.18/0.29

400-km Pb-Acid Hyb
Bipolar
5-Passenger



VEHICLE DATA

Seating Capacity	5
Curb Weight (kg/lb)	1436/3159
Test Weight (kg/lb)	1572/3458
Weight Dist. [f/r (%)]	55/45
Wheelbase (in./cm)	107/272
Length (in./cm)	184/467
Width (in./cm)	70/178
Height (in./cm)	54/138
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	500+/17.6+
Fuel Capacity (gal/l)	10/40

BATTERY

Name	Pb-Acid Bipolar
Weight (kg/lb)	224/493
Volume (l/cu ft)	113/4.0

MOTOR

Type	AC
Weight (kg/lb)	81/178
Volume (l/cu ft)	26/0.9
Rated Power (Cont. kW)	39.6

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	18/40
Volume (l/cu ft)	44/1.6
Rated Power (kW)	44

ENGINE

Type	4 cyl-SI
Displacement	2000cc/kW
Compression Ratio	12
Weight (kg/lb)	98/216
Volume (l/cu ft)	88/3.1
Rated Power (kW)	44
Fuel	Methanol

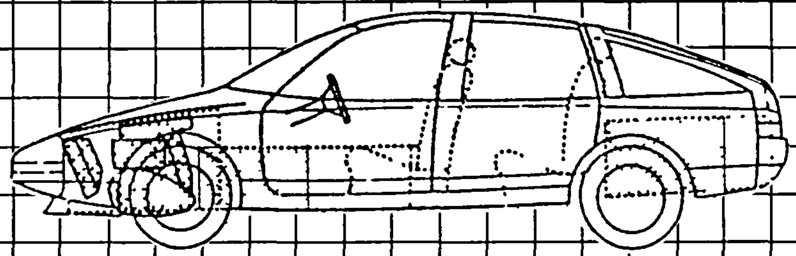
DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	31/68
Volume (l/cu ft)	16/0.6
Rated Power (kW)	44
Engine Transmission type	CVT
Weight (kg/lb)	40/88
Volume (l/cm ft)	52/1.8
Rated Power (kW)	44

CALCULATED DATA

Range (km/mi)	80/50 electric 400/250 engine
Fuel Economy	
Electric Mode (kWh/km/mi)	0.16/0.26
Annual Energy (kWh)	1964
Heat Engine Mode (mpg)	25
Annual fuel (l/g)	428/107
Cost - 1982$	
Initial	12672
Operating ($/km/mi)	0.15/0.24
Life Cycle ($/km/mi)	0.16/0.26

400-km Ni-Fe Hyb
5-Passenger



VEHICLE DATA

Seating Capacity	5
Curb Weight (kg/lb)	1618/3560
Test Weight (kg/lb)	1754/3859
Weight Dist. [f/r (%)]	57/43
Wheelbase (in./cm)	107/272
Length (in./cm)	184/467
Width (in./cm)	70/178
Height (in./cm)	54/138
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	500+/17.6+
Fuel Capacity (gal/l)	10/40

BATTERY

Name	Ni-Fe
Weight (kg/lb)	333/733
Volume (l/cu ft)	172/6.1

MOTOR

Type	AC
Weight (kg/lb)	90/198
Volume (l/cu ft)	29/1.0
Rated Power (Cont. kW)	44.2

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	20/44
Volume (l/cu ft)	49/1.7
Rated Power (kW)	49.1

ENGINE

Type	4 cyl-SI
Displacement	2000cc/kW
Compression Ratio	12
Weight (kg/lb)	109/240
Volume (l/cu ft)	98/3.5
Rated Power (kW)	49.1
Fuel	Methanol

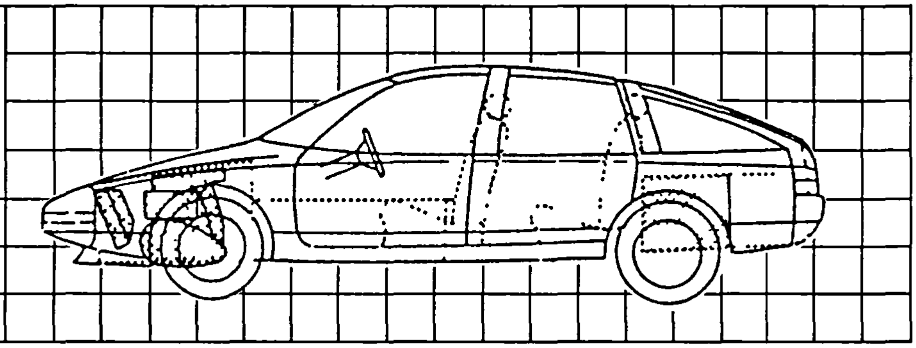
DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	35/77
Volume (l/cu ft)	18/0.6
Rated Power (kW)	49.1
Engine Transmission type	CVT
Weight (kg/lb)	45/99
Volume (l/cm ft)	58/2.0
Rated Power (kW)	49.1

CALCULATED DATA

Range (km/mi)	80/50 electric 336/210 engine
Fuel Economy	
Electric Mode (kWh/km/mi)	0.28/0.45
Annual Energy (kWh)	3535
Heat Engine Mode (mpg)	21
Annual fuel (l/g)	465/116
Cost - 1982$	
Initial	16328
Operating ($/km/mi)	0.16/0.26
Life Cycle ($/km/mi)	0.18/0.29

400-km Ni-Zn Hyb
5-Passenger



VEHICLE DATA

Seating Capacity	5
Curb Weight (kg/lb)	1445/3179
Test Weight (kg/lb)	1581/3478
Weight Dist. [f/r (%)]	56/44
Wheelbase (in./cm)	107/272
Length (in./cm)	184/467
Width (in./cm)	70/178
Height (in./cm)	54/138
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	$500^{+}/17.6^{+}$
Fuel Capacity (gal/l)	10/40

BATTERY

Name	Ni-Zn
Weight (kg/lb)	229/504
Volume (l/cu ft)	137/4.8

MOTOR

Type	AC
Weight (kg/lb)	81/178
Volume (l/cu ft)	26/0.9
Rated Power (Cont. kW)	39.8

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	18/40
Volume (l/cu ft)	44/1.6
Rated Power (kW)	44.3

ENGINE

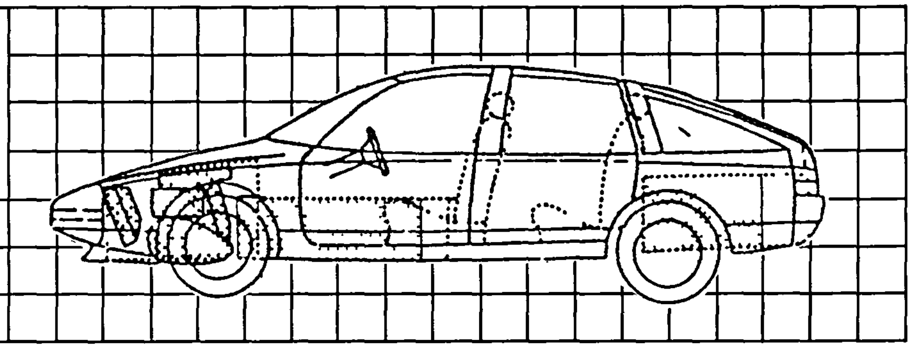
Type	4 cyl-SI
Displacement	2000cc/kW
Compression Ratio	12
Weight (kg/lb)	98/216
Volume (l/cu ft)	88/3.1
Rated Power (kW)	44.2
Fuel	Methanol

DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	31/68
Volume (l/cu ft)	16/0.6
Rated Power (kW)	44.2
Engine Transmission type	CVT
Weight (kg/lb)	40/88
Volume (l/cm ft)	52/1.8
Rated Power (kW)	44.2

CALCULATED DATA

Range (km/mi)	80/50 electric 368/230 engine
Fuel Economy	
Electric Mode (kWh/km/mi)	0.20/0.32
Annual Energy (kWh)	2541
Heat Engine Mode (mpg)	23
Annual fuel (l/g)	430/108
Cost - 1982$	
Initial	13683
Operating ($/km/mi)	0.17/0.27
Life Cycle ($/km/mi)	0.17/0.27



400-km Zn-Br_2 Hyb
5-Passenger

VEHICLE DATA

Seating Capacity	5
Curb Weight (kg/lb)	1783/3923
Test Weight (kg/lb)	1919/4222
Weight Dist. [f/r (%)]	59/41
Wheelbase (in./cm)	107/272
Length (in./cm)	184/467
Width (in./cm)	70/178
Height (in./cm)	54/138
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	$500^+/17.6^+$
Fuel Capacity (gal/l)	10/40

BATTERY

Name	Zn-Br_2
Weight (kg/lb)	432/950
Volume (l/cu ft)	326/11.5

MOTOR

Type	AC
Weight (kg/lb)	99/218
Volume (l/cu ft)	31/1.1
Rated Power (Cont. kW)	48.4

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	21/46
Volume (l/cu ft)	54/1.9
Rated Power (kW)	53.7

ENGINE

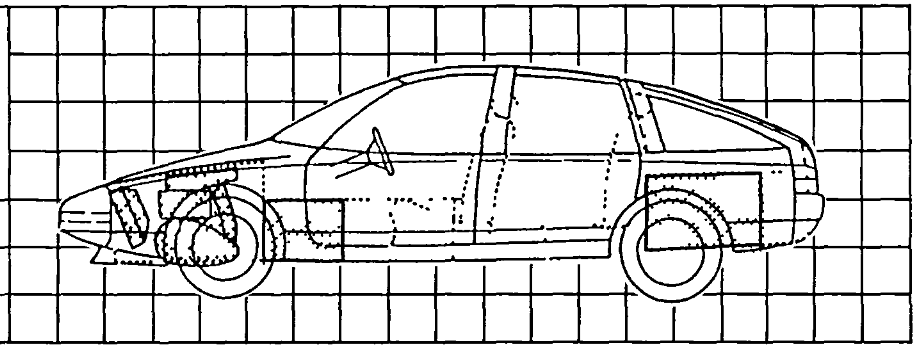
Type	4 cyl-SI
Displacement	2000cc/kW
Compression Ratio	12
Weight (kg/lb)	119/262
Volume (l/cu ft)	107/3.8
Rated Power (kW)	53.7
Fuel	Methanol

DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	38/84
Volume (l/cu ft)	19/0.7
Rated Power (kW)	53.7
Engine Transmission type	CVT
Weight (kg/lb)	49/108
Volume (l/cm ft)	63/2.2
Rated Power (kW)	53.7

CALCULATED DATA

Range (km/mi)	80/50 electric 336/210 engine
Fuel Economy	
Electric Mode (kWh/km/mi)	0.38/0.60
Annual Energy (kWh)	4648
Heat Engine Mode (mpg)	21
Annual fuel (l/g)	512/128
Cost - 1982$	
Initial	15158
Operating ($/km/mi)	0.20/0.32
Life Cycle ($/km/mi)	0.20/0.32



400-km Zn-Cl_2 Hyb
5-Passenger

VEHICLE DATA

Seating Capacity	5
Curb Weight (kg/lb)	1685/3707
Test Weight (kg/lb)	1821/4006
Weight Dist. [f/r (%)]	53/47
Wheelbase (in./cm)	107/272
Length (in./cm)	184/467
Width (in./cm)	70/178
Height (in./cm)	54/138
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	$500^+/17.6^+$
Fuel Capacity (gal/l)	10/40

BATTERY

Name	Zn-Cl_2
Weight (kg/lb)	373/821
Volume (l/cu ft)	280/9.9

MOTOR

Type	AC
Weight (kg/lb)	94/207
Volume (l/cu ft)	30/1.1
Rated Power (Cont. kW)	45.9

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	20/44
Volume (l/cu ft)	51/1.8
Rated Power (kW)	51

ENGINE

Type	4 cyl-SI
Displacement	2000cc/kW
Compression Ratio	12
Weight (kg/lb)	113/249
Volume (l/cu ft)	102/3.6
Rated Power (kW)	51
Fuel	Methanol

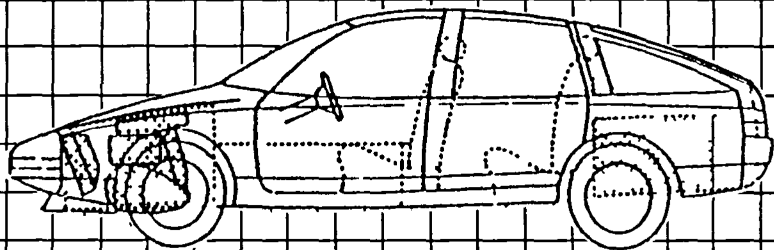
DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	36/79
Volume (l/cu ft)	18/0.6
Rated Power (kW)	51
Engine Transmission type	CVT
Weight (kg/lb)	47/103
Volume (l/cm ft)	60/2.1
Rated Power (kW)	51

CALCULATED DATA

Range (km/mi)	80/50 electric 336/210 engine
Fuel Economy	
Electric Mode (kWh/km/mi)	0.33/0.53
Annual Energy (kWh)	4143
Heat Engine Mode (mpg)	21
Annual fuel (l/g)	478/120
Cost - 1982$	
Initial	17215
Operating ($/km/mi)	0.20/0.32
Life Cycle ($/km/mi)	0.19/0.30

400-km Fe-Air Hyb
5-Passenger



VEHICLE DATA

Seating Capacity	5
Curb Weight (kg/lb)	1537/3381
Test Weight (kg/lb)	1673/3681
Weight Dist. [f/r (%)]	52/48
Wheelbase (in./cm)	107/272
Length (in./cm)	184/467
Width (in./cm)	70/178
Height (in./cm)	54/138
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	500+/17.6+
Fuel Capacity (gal/l)	10/40

BATTERY

Name	Fe-Air
Weight (kg/lb)	284/625
Volume (l/cu ft)	197/7.0

MOTOR

Type	AC
Weight (kg/lb)	86/189
Volume (l/cu ft)	27/1.0
Rated Power (Cont. kW)	44.2

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	19/42
Volume (l/cu ft)	47/1.7
Rated Power (kW)	46.8

ENGINE

Type	4 cyl-SI
Displacement	2000cc/kW
Compression Ratio	12
Weight (kg/lb)	104/229
Volume (l/cu ft)	94/3.3
Rated Power (kW)	46.8
Fuel	Methanol

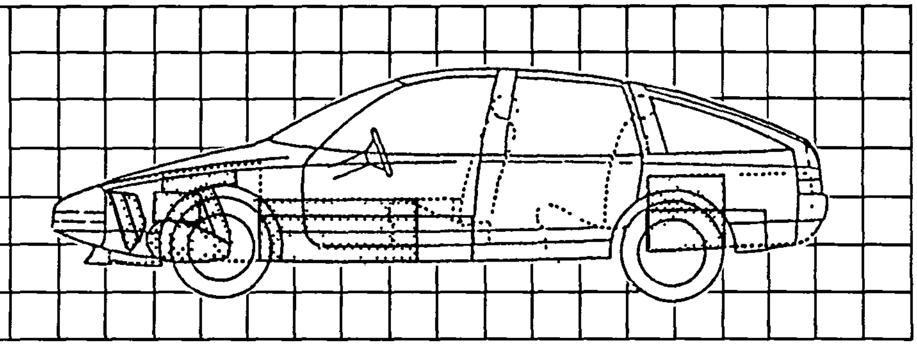
DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Weight (kg/lb)	33/73
Volume (l/cu ft)	17/0.6
Rated Power (kW)	46.8
Engine Transmission type	CVT
Weight (kg/lb)	43/95
Volume (l/cm ft)	55/1.9
Rated Power (kW)	46.8

CALCULATED DATA

Range (km/mi)	80/50 electric 336/210 engine
Fuel Economy	
Electric Mode (kWh/km/mi)	0.35/0.57
Annual Energy (kWh)	4482
Heat Engine Mode (mpg)	21
Annual fuel (l/g)	470/118
Cost - 1982$	
Initial	14574
Operating ($/km/mi)	0.21/0.34
Life Cycle ($/km/mi)	0.22/0.35

400-km Li-FeS Hyb
5-Passenger



VEHICLE DATA

Seating Capacity..........	5
Curb Weight (kg/lb).......	1517/3337
Test Weight (kg/lb).......	1653/3637
Weight Dist. [f/r (%)]....	62/38
Wheelbase (in./cm)........	107/272
Length (in./cm)...........	184/467
Width (in./cm)............	70/178
Height (in./cm)...........	54/138
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	500+/17.6+
Fuel Capacity (gal/l).....	10/40

BATTERY

Name......................	Li-FeS
Weight (kg/lb)............	273/601
Volume (l/cu ft)..........	195/6.9

MOTOR

Type......................	AC
Weight (kg/lb)............	85/187
Volume (l/cu ft)..........	27/1.0
Rated Power (Cont. kW)....	41.7

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	19/42
Volume (l/cu ft)..........	46/1.6
Rated Power (kW)..........	46.3

ENGINE

Type...........................	4 cyl-SI
Displacement...................	2000cc/kW
Compression Ratio..............	12
Weight (kg/lb).................	103/227
Volume (l/cu ft)...............	93/3.3
Rated Power (kW)...............	46.3
Fuel...........................	Methanol

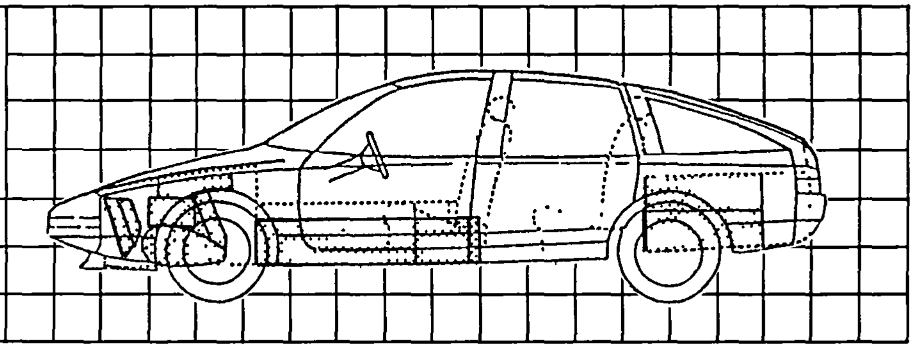
DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	33/73
Volume (l/cu ft)...............	17/0.6
Rated Power (kW)...............	46.3
Engine Transmission type.......	CVT
Weight (kg/lb).................	42/92
Volume (l/cm ft)...............	54/1.9
Rated Power (kW)...............	46.3

CALCULATED DATA

Range (km/mi)..............	80/50 electric 352/220 engine
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.25/0.40
Annual Energy (kWh)..........	3161
Heat Engine Mode (mpg).......	22
Annual fuel (l/g)............	445/111
Cost - 1982$	
Initial......................	15485
Operating ($/km/mi)..........	0.18/0.29
Life Cycle ($/km/mi).........	0.18/0.29

400-km Na-S Hyb
5-Passenger



VEHICLE DATA

Seating Capacity..........	5
Curb Weight (kg/lb).......	1340/2948
Test Weight (kg/lb).......	1476/3247
Weight Dist. [f/r (%)]....	56/44
Wheelbase (in./cm)........	107/272
Length (in./cm)...........	184/467
Width (in./cm)............	70/178
Height (in./cm)...........	54/138
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	500+/17.6+
Fuel Capacity (gal/l).....	10/40

BATTERY

Name......................	Na-S
Weight (kg/lb)............	167/367
Volume (l/cu ft)..........	151/5.3

MOTOR

Type......................	AC
Weight (kg/lb)............	76/167
Volume (l/cu ft)..........	24/0.8
Rated Power (Cont. kW)....	37.2

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	17/37
Volume (l/cu ft)..........	41/1.4
Rated Power (kW)..........	41.3

ENGINE

Type...........................	4 cyl-SI
Displacement...................	2000cc/kW
Compression Ratio..............	12
Weight (kg/lb).................	92/202
Volume (l/cu ft)...............	83/2.9
Rated Power (kW)...............	41.3
Fuel...........................	Methanol

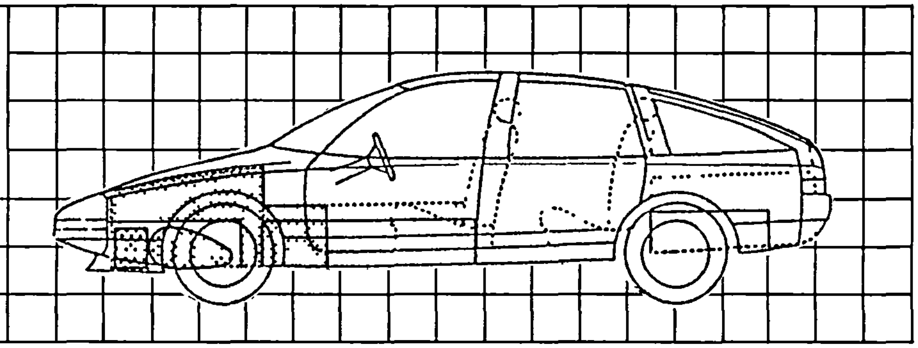
DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Weight (kg/lb).................	29/64
Volume (l/cu ft)...............	15/0.5
Rated Power (kW)...............	41.3
Engine Transmission type.......	CVT
Weight (kg/lb).................	38/84
Volume (l/cm ft)...............	49/1.7
Rated Power (kW)...............	41.3

CALCULATED DATA

Range (km/mi)..............	80/50 electric 400/250 engine
Fuel Economy	
Electric Mode (kWh/km/mi)....	0.20/0.32
Annual Energy (kWh)..........	2540
Heat Engine Mode (mpg).......	25
Annual fuel (l/g)............	409/102
Cost - 1982$	
Initial......................	14951
Operating ($/km/mi)..........	0.20/0.32
Life Cycle ($/km/mi).........	0.20/0.32

400-km SPE Fuel Cell
5-Passenger



VEHICLE DATA

Seating Capacity	5
Curb Weight (kg/lb)	1205/2651
Test Weight (kg/lb)	1341/2950
Weight Dist. [f/r (%)]	65/35
Wheelbase (in./cm)	107/272
Length (in./cm)	184/467
Width (in./cm)	70/178
Height (in./cm)	54/138
Ground Clearance (in./cm)	8/20
Luggage Space (l/cu ft)	650/23
Fuel Capacity (gal/l)	10/40

BATTERY

Type	
Weight (kg/lb)	
Volume (l/cu ft)	
Sp. Power at %SOC-W/kg	
Sp. Energy to %SOC-W/kg	

MOTOR

Type	AC
Weight (kg/lb)	76/167
Volume (l/cu ft)	55/1.9
Peak Power (kW)	40
Cont. Power (kW)	36

CONTROLLER

Type	Mod Inverter
Weight (kg/lb)	16/35
Volume (l/cu ft)	19/0.7
Peak Power (kW)	40

ENGINE/FUEL CELL

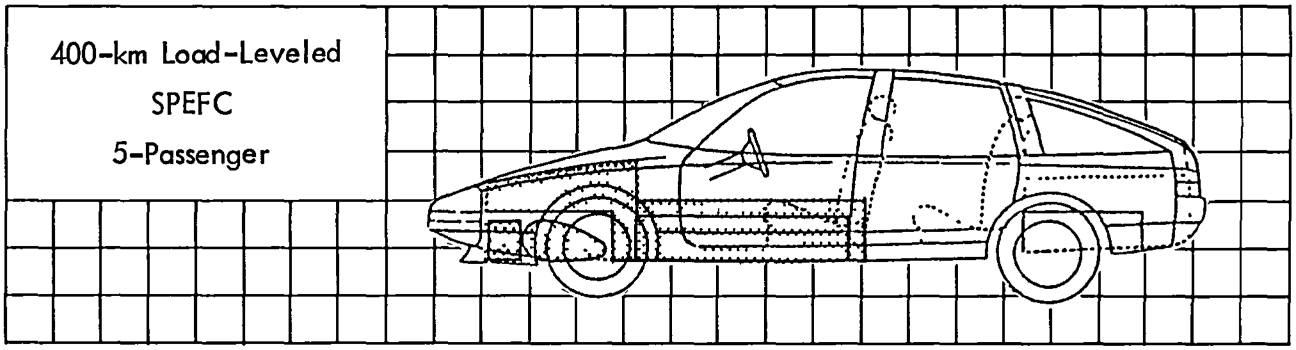
Type	SPE
Weight (kg/lb)	216/475
Volume (l/cu ft)	309/11
Continuous (Power-kW)	37
Peak (Power-kW)	56
Fuel	Methanol

DRIVETRAIN

Motor Trans. Type	Fixed Reduction
Motor Trans. Ratio	16:1
Engine Trans. Type	
Engine Trans. Ratio	

CALCULATED DATA

Range (km/mi)	464/290
Fuel Economy	
Elec. Mode (kWh per km/mi)	
Annual Energy (kWh)	
Fuel Cell Mode (mpg)	29
Annual Methanol (gal/l)	358
Cost - 1982$	
Initial	17,550
Battery/Fuel Cell	7340
Operating ($/km/mi)	0.18/0.28
Life Cycle ($/km/mi)	0.19/0.30



VEHICLE DATA

Seating Capacity..........	5
Curb Weight (kg/lb).......	1243
Test Weight (kg/lb).......	1379
Weight Dist. [f/r (%)]....	65/35
Wheelbase (in./cm)........	107/272
Length (in./cm)...........	184/467
Width (in./cm)............	70/178
Height (in./cm)...........	54/138
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	700
Fuel Capacity (gal/l).....	10/40

BATTERY

Type......................	Pb-Acid
Weight (kg/lb)............	120
Volume (l/cu ft)..........	55

MOTOR

Type......................	AC
Weight (kg/lb)............	76
Volume (l/cu ft)..........	55
Peak Power (kW)...........	41
Cont. Power (kW)..........	36

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	16
Volume (l/cu ft)..........	19
Peak Power (kW)...........	41

FUEL CELL

Type...........................	SPE
Weight (kg)....................	153
Volume (l).....................	339
Max Rated Power (kW)...........	20
Fuel...........................	Methanol

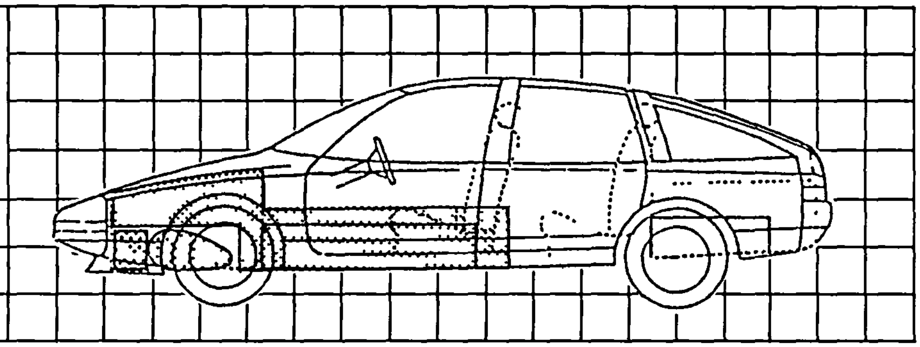
DRIVETRAIN

Motor Trans. Type..............	Fixed Reduction
Motor Trans. Ratio.............	16:1
Engine Trans. Type.............	
Engine Trans. Ratio............	

CALCULATED DATA

Cycle Range (km/mi)............	
Cycle Range (km/mi)............	
Fuel Economy	
Elec. Mode (kWh per km/mi)...	
Annual Energy (kWh)..........	
Heat Engine Mode (mpg).......	33
Annual Methanol (gal/l)......	315/1190
Cost - 1982$	
Initial......................	18,030
Battery/Fuel Cell.......	6,600
Operating ($/km/mi)..........	0.08/0.13
Life Cycle ($/km/mi).........	0.21/0.34

400-km Load-Leveled PAFC 5-Passenger



VEHICLE DATA

Seating Capacity..........	5
Curb Weight (kg/lb).......	1598/3516
Test Weight (kg/lb).......	1734/3815
Weight Dist. [f/r (%)]....	67/33
Wheelbase (in./cm)........	107/272
Length (in./cm)...........	184/467
Width (in./cm)............	70/178
Height (in./cm)...........	54/138
Ground Clearance (in./cm).	8/20
Luggage Space (l/cu ft)...	700/24.7
Fuel Capacity (gal/l).....	10/40

BATTERY

Type......................	Pb-Acid
Weight (kg/lb)............	200
Volume (l/cu ft)..........	91

MOTOR

Type......................	AC
Weight (kg/lb)............	100
Volume (l/cu ft)..........	72
Peak Power-kW.............	52
Cont. Power-kW............	47

CONTROLLER

Type......................	Mod Inverter
Weight (kg/lb)............	21
Volume (l/cu ft)..........	25
Peak Power (kW)...........	52

ENGINE/FUEL CELL

Type..........................	PA
Weight (kg)...................	227
Volume (l)....................	340
Continuous (Power-kW).........	20
Peak (Power-kW)...............	20
Fuel..........................	Methanol/Air

DRIVETRAIN

Motor Trans. Type.............	Fixed Reduction
Motor Trans. Ratio............	16:1
Engine Trans. Type............	
Engine Trans. Ratio...........	

CALCULATED DATA

Range (km/mi).................	480/300
Fuel Economy	
Elec. Mode (kWh per km/mi)...	
Annual Energy (kWh)..........	
Fuel Cell Mode (mpg).........	30
Annual Methanol (gal/l)......	350/1320
Cost - 1982$	
Initial......................	21,630
Fuel Cell....................	8000
Operating ($/km/mi)..........	0.07/0.11
Life Cycle ($/km/mi).........	0.24/0.38

APPENDIX B

VEHICLE COST SHEETS

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ELECTRIC AND HYBRID VEHICLE COST MODEL

                              BASELINE VAN          07-18-1984

                              *--INPUTS--*

 GENERAL --                             YEAR:      1982
VEHICLE SIZE:  VAN                      REAL INTEREST RATE:   10 %
CURB WEIGHT:  1080 KG                   VEHICLE SALVAGE VALUE:     10 %
VEHICLE WEIGHT , WT:   1375
LIFE:              128480 KM            ACCESSORY COST:   $ 200

 BATTERY --                             NAME:   XX
BATTERY WEIGHT:     0 KG                BATTERY CYCLE LIFE:   1
ELECTRICITY COST:     .05 $/KW-H        MAXIMUM SHELF LIFE:    10 YEARS
AVERAGE DAILY DEPTH OF DISCHARGE:  1    DEPTH OF A DEEP DISCHARGE:  .8
MAINTENANCE FACTOR:   1

 ENGINE --                              FUEL COST:     .373 $/L
TANK CAPACITY:     40 L                 FUEL TYPE:   METHANOL
ICE TRANSMISSION TYPE:  CVT             POWER:   41.3 KW

 MOTOR --
RATED POWER:           0 KW             TYPE:         AC
CONTROLLER:        0  KW
EV TRANSMISSION TYPE:   fixed ratio

 DRIVING --                             AMOUNT:    12848 KM/YEAR
ICE FRACTIONAL RANGE:     100 %         EV FRACTIONAL RANGE:     0 %
ANNUAL FUEL USE:     2034  L            ANNUAL ELEC USE:     0 KW-H

                             *-- OUTPUTS --*

COST ITEMS-
                              $     C/KM
BASIC VEHICLE COST         6807.20  5.298
ENGINE COST                1229.04  0.957
ICE TRANSMISSION COST       461.32  0.359
MOTOR COST                    0.00  0.000
CONTROLLER COST               0.00  0.000
EV TRANSMISSION COST          0.00  0.000
BATTERY      LOW              0.00  0.000  HIGH     0.00  0.000
                           -------  -----
INITIAL COST     LOW       8497.56  6.614  HIGH 8497.56  6.614
DOWNPAYMENT    LOW         1699.51  1.323  HIGH 1699.51  1.323


REPLACEM'T BATTS LOW          0.00  0.000  HIGH     0.00  0.000
REPAIRS & MAINTENANCE      4633.47  3.606
REPLACEMENT TIRES           280.86  0.219
INSURANCE                  3479.00  2.708
GARAGING,PARK, TOLL         782.50  0.609
TITLE, REG, LIC, LOW.       624.88  0.486  HIGH  624.88  0.486
FUEL-OIL                   7814.42  6.082
ELECTRICITY                   0.00  0.000
PRIN & INT LOW             6798.05  5.291  HIGH 6798.05  5.291
                           -------  -----
OPERATING COST  LOW       24413.18 19.002  HIGH24413.18 19.002


VEHICLE SALVAGE VALUE  LOW  327.62  0.255  HIGH  327.62  0.255
BATTERY SALVAGE  LOW          0.00  0.000  HIGH     0.00  0.000


TOTAL LIFE CYCLE COST  LOW25785.08 20.069  HIGH25785.08 20.069
```

ELECTRIC AND HYBRID VEHICLE COST MODEL

PB/ACID VAN 09-12-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: VAN
CURB WEIGHT: 1735 KG
VEHICLE WEIGHT , WT: 2030
LIFE: 128480 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 453 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .3188406

NAME: PBAC/AD2.4
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 37.1 KW
CONTROLLER: 41.2 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 3075.49 KW-H

AMOUNT: 12848 KM/YEAR

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		8267.50	6.435			
MOTOR COST		704.90	0.549			
CONTROLLER COST		1854.00	1.443			
EV TRANSMISSION COST		191.58	0.149			
BATTERY	LOW	2360.03	1.837	HIGH	2832.03	2.204
INITIAL COST	LOW	13378.01	10.413	HIGH	13850.02	10.780
DOWNPAYMENT	LOW	2675.60	2.083	HIGH	2770.00	2.156
REPLACEM'T BATTS	LOW	2360.03	1.837	HIGH	2832.03	2.204
REPAIRS & MAINTENANCE		2281.97	1.776			
REPLACEMENT TIRES		339.85	0.265			
INSURANCE		3479.00	2.708			
GARAGING, PARK, TOLL		782.50	0.609			
TITLE, REG, LIC,	LOW.	868.90	0.676	HIGH	892.50	0.695
ELECTRICITY		1537.75	1.197			
PRIN & INT	LOW	10702.41	8.330	HIGH	11080.01	8.624
OPERATING COST	LOW	22352.40	17.398	HIGH	22753.61	17.710
VEHICLE SALVAGE VALUE	LOW	567.30	0.442	HIGH	595.81	0.464
BATTERY SALVAGE	LOW	30.83	0.024	HIGH	30.83	0.024
TOTAL LIFE CYCLE COST	LOW	24429.86	19.015	HIGH	24896.97	19.378

ELECTRIC AND HYBRID VEHICLE COST MODEL

BIPOLAR VAN 09-12-1984

--INPUTS--

GENERAL — YEAR: 1982
VEHICLE SIZE: VAN REAL INTEREST RATE: 10 %
CURB WEIGHT: 1510 KG VEHICLE SALVAGE VALUE: 10 %
VEHICLE WEIGHT , WT: 1805
LIFE: 128480 KM ACCESSORY COST: $ 200

BATTERY — NAME: PB-AC/BIPL
BATTERY WEIGHT: 293 KG BATTERY CYCLE LIFE: 750
ELECTRICITY COST: .05 $/KW-H MAXIMUM SHELF LIFE: 10 YEARS
AVERAGE DAILY DEPTH OF DISCHARGE: .3548387
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: .5

TRANSMISSION TYPE: fixed ratio
MOTOR —
RATED POWER: 33 KW TYPE: AC
CONTROLLER: 36.6 KW

DRIVING — AMOUNT: 12848 KM/YEAR
ANNUAL ELEC USE: 2392.94 KW-H

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		7909.21	6.156			
MOTOR COST		627.00	0.488			
CONTROLLER COST		1647.00	1.282			
EV TRANSMISSION COST		170.19	0.132			
BATTERY	LOW	1598.18	1.244	HIGH	2397.27	1.866
INITIAL COST	LOW	11951.58	9.302	HIGH	12750.67	9.924
DOWNPAYMENT	LOW	2390.32	1.860	HIGH	2550.13	1.985
REPLACEM'T BATTS	LOW	3196.36	2.488	HIGH	4794.55	3.732
REPAIRS & MAINTENANCE		1549.64	1.206			
REPLACEMENT TIRES		319.58	0.249			
INSURANCE		3479.00	2.708			
GARAGING,PARK, TOLL		782.50	0.609			
TITLE, REG, LIC,	LOW.	797.58	0.621	HIGH	837.53	0.652
ELECTRICITY		1196.47	0.931			
PRIN & INT	LOW	9561.26	7.442	HIGH	10200.54	7.939
OPERATING COST	LOW	20882.40	16.253	HIGH	21561.62	16.782
VEHICLE SALVAGE VALUE	LOW	1743.88	1.357	HIGH	2416.23	1.881
BATTERY SALVAGE	LOW	48.64	0.038	HIGH	48.64	0.038
TOTAL LIFE CYCLE COST	LOW	21480.20	16.719	HIGH	21646.89	16.848

ELECTRIC AND HYBRID VEHICLE COST MODEL

NI/FE VAN 09-12-1984

--INPUTS--

GENERAL --	YEAR: 1982
VEHICLE SIZE: VAN	REAL INTEREST RATE: 10 %
CURB WEIGHT: 1644 KG	VEHICLE SALVAGE VALUE: 10 %
VEHICLE WEIGHT , WT: 1939	
LIFE: 128480 KM	ACCESSORY COST: $ 200
BATTERY --	NAME: NI-FE2.4
BATTERY WEIGHT: 388 KG	BATTERY CYCLE LIFE: 1500
ELECTRICITY COST: .05 $/KW-H	MAXIMUM SHELF LIFE: 10 YEARS
AVERAGE DAILY DEPTH OF DISCHARGE: .2730556	
	DEPTH OF A DEEP DISCHARGE: .8
MAINTENANCE FACTOR: 1.25	
TRANSMISSION TYPE: fixed ratio	
MOTOR --	
RATED POWER: 35.4 KW	TYPE: AC
CONTROLLER: 39.4 KW	
DRIVING --	AMOUNT: 12848 KM/YEAR
ANNUAL ELEC USE: 4069.245 KW-H	

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	8124.73	6.324			
MOTOR COST	672.60	0.524			
CONTROLLER COST	1773.00	1.380			
EV TRANSMISSION COST	183.21	0.143			
BATTERY LOW	4263.66	3.319	HIGH	4737.40	3.687
INITIAL COST LOW	15017.20	11.688	HIGH	15490.94	12.057
DOWNPAYMENT LOW	3003.44	2.338	HIGH	3098.19	2.411
REPLACEM'T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	2648.14	2.061			
REPLACEMENT TIRES	331.65	0.258			
INSURANCE	3479.00	2.708			
GARAGING,PARK, TOLL	782.50	0.609			
TITLE, REG, LIC, LOW.	950.86	0.740	HIGH	974.55	0.759
ELECTRICITY	2034.62	1.584			
PRIN & INT LOW	12013.76	9.351	HIGH	12392.75	9.646
OPERATING COST LOW	22240.54	17.311	HIGH	22643.21	17.624
VEHICLE SALVAGE VALUE LOW	414.60	0.323	HIGH	414.60	0.323
BATTERY SALVAGE LOW	132.35	0.103	HIGH	132.35	0.103
TOTAL LIFE CYCLE COST LOW	24697.03	19.222	HIGH	25194.45	19.610

ELECTRIC AND HYBRID VEHICLE COST MODEL

NI/ZN VAN 09-12-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: VAN
CURB WEIGHT: 1455 KG
VEHICLE WEIGHT , WT: 1750
LIFE: 128480 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 254 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .3188406

NAME: NI-ZN2.0
BATTERY CYCLE LIFE: 600
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: .75

TRANSMISSION TYPE: fixed ratio

MOTOR --
RATED POWER: 32 KW
CONTROLLER: 35.5 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 2955.04 KW-H

AMOUNT: 12848 KM/YEAR

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		7820.63	6.087			
MOTOR COST		608.00	0.473			
CONTROLLER COST		1597.50	1.243			
EV TRANSMISSION COST		165.08	0.128			
BATTERY	LOW	2431.47	1.892	HIGH	2674.62	2.082
INITIAL COST	LOW	12622.68	9.825	HIGH	12865.83	10.014
DOWNPAYMENT	LOW	2524.54	1.965	HIGH	2573.17	2.003
REPLACEM'T BATTS	LOW	4862.95	3.785	HIGH	5349.24	4.163
REPAIRS & MAINTENANCE		1915.80	1.491			
REPLACEMENT TIRES		314.63	0.245			
INSURANCE		3479.00	2.708			
GARAGING,PARK, TOLL		782.50	0.609			
TITLE, REG, LIC,	LOW.	831.13	0.647	HIGH	843.29	0.656
ELECTRICITY		1477.52	1.150			
PRIN & INT	LOW	10098.14	7.860	HIGH	10292.66	8.011
OPERATING COST	LOW	23761.68	18.494	HIGH	23968.35	18.655
VEHICLE SALVAGE VALUE	LOW	1792.19	1.395	HIGH	1932.11	1.504
BATTERY SALVAGE	LOW	311.81	0.243	HIGH	311.81	0.243
TOTAL LIFE CYCLE COST	LOW	24182.22	18.822	HIGH	24297.60	18.912

ELECTRIC AND HYBRID VEHICLE COST MODEL

ZN/BR VAN 09-12-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: VAN
CURB WEIGHT: 1722 KG
VEHICLE WEIGHT , WT: 2017
LIFE: 128480 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 444 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .3097282

NAME: ZN-BR2/2.4
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 36.9 KW
CONTROLLER: 41 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 5172.415 KW-H

AMOUNT: 12848 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	8244.07	6.417			
MOTOR COST	701.10	0.546			
CONTROLLER COST	1845.00	1.436			
EV TRANSMISSION COST	190.65	0.148			
BATTERY LOW	2365.25	1.841	HIGH	4068.24	3.166
INITIAL COST LOW	13346.08	10.388	HIGH	15049.06	11.713
DOWNPAYMENT LOW	2669.22	2.078	HIGH	3009.81	2.343
REPLACEM'T BATTS LOW	2365.25	1.841	HIGH	4068.24	3.166
REPAIRS & MAINTENANCE	3746.64	2.916			
REPLACEMENT TIRES	338.67	0.264			
INSURANCE	3479.00	2.708			
GARAGING, PARK, TOLL	782.50	0.609			
TITLE, REG, LIC, LOW.	867.30	0.675	HIGH	952.45	0.741
ELECTRICITY	2586.21	2.013			
PRIN & INT LOW	10676.86	8.310	HIGH	12039.25	9.371
OPERATING COST LOW	24842.45	19.336	HIGH	26289.98	20.462
VEHICLE SALVAGE VALUE LOW	697.30	0.543	HIGH	894.54	0.696
BATTERY SALVAGE LOW	43.51	0.034	HIGH	43.51	0.034
TOTAL LIFE CYCLE COST LOW	26770.85	20.837	HIGH	28361.74	22.075

ELECTRIC AND HYBRID VEHICLE COST MODEL

ZN/CL VAN 09-12-1984

--INPUTS--

GENERAL --
VLHICLE SIZE: VAN
CURB WEIGHT: 1591 KG
VEHICLE WEIGHT , WT: 1886
LIFE: 128480 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 350 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .294487

NAME: ZN-CL2/2.4
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 34.5 KW
CONTROLLER: 38.3 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 4563.27 KW-H

AMOUNT: 12848 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	8041.68	6.259			
MOTOR COST	655.50	0.510			
CONTROLLER COST	1723.50	1.341			
EV TRANSMISSION COST	178.10	0.139			
BATTERY LOW	4553.52	3.544	HIGH	4735.66	3.686
	-------	------			
INITIAL COST LOW	15152.30	11.794	HIGH	15334.44	11.935
DOWNPAYMENT LOW	3030.46	2.359	HIGH	3066.89	2.387
REPLACEM'T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	3746.64	2.916			
REPLACEMENT TIRES	326.88	0.254			
INSURANCE	3479.00	2.708			
GARAGING, PARK, TOLL	782.50	0.609			
TITLE, REG, LIC, LOW.	957.62	0.745	HIGH	966.72	0.752
ELECTRICITY	2281.64	1.776			
PRIN & INT LOW	12121.84	9.435	HIGH	12267.55	9.548
	-------	------			
OPERATING COST LOW	23696.11	18.443	HIGH	23850.93	18.564
VEHICLE SALVAGE VALUE LOW	408.63	0.318	HIGH	408.63	0.318
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	26317.95	20.484	HIGH	26509.19	20.633

ELECTRIC AND HYBRID VEHICLE COST MODEL

FE/AIR VAN 09-12-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: VAN
CURB WEIGHT: 1492 KG
VEHICLE WEIGHT , WT: 1787
LIFE: 128480 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 280 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .3099859

NAME: FE-AIR2.4
BATTERY CYCLE LIFE: 500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 33 KW
CONTROLLER: 36 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 5029.875 KW-H

AMOUNT: 12848 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM		
BASIC VEHICLE COST	7879.06	6.133		
MOTOR COST	627.00	0.488		
CONTROLLER COST	1620.00	1.261		
EV TRANSMISSION COST	167.40	0.130		
BATTERY LOW	2660.89	2.071	HIGH 4869.43	3.790
INITIAL COST LOW	12954.35	10.083	HIGH15162.89	11.802
DOWNPAYMENT LOW	2590.87	2.017	HIGH 3032.58	2.360
REPLACEM'T BATTS LOW	5321.78	4.142	HIGH 9738.86	7.580
REPAIRS & MAINTENANCE	3746.64	2.916		
REPLACEMENT TIRES	317.96	0.247		
INSURANCE	3479.00	2.708		
GARAGING, PARK, TOLL	782.50	0.609		
TITLE, REG, LIC, LOW.	847.72	0.660	HIGH 958.14	0.746
ELECTRICITY	2514.94	1.957		
PRIN & INT LOW	10363.48	8.066	HIGH12130.31	9.441
OPERATING COST LOW	27374.02	21.306	HIGH29251.28	22.767
VEHICLE SALVAGE VALUE LOW	852.88	0.664	HIGH 1231.37	0.958
BATTERY SALVAGE LOW	0.00	0.000	HIGH 0.00	0.000
TOTAL LIFE CYCLE COST LOW	29112.02	22.659	HIGH31052.49	24.169

ELECTRIC AND HYBRID VEHICLE COST MODEL

LI/FES VAN 09-12-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: VAN
CURB WEIGHT: 1486 KG
VEHICLE WEIGHT , WT: 1781
LIFE: 128480 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 276 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2444445

NAME: LI-FE-S2.4
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.25

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 32.5 KW
CONTROLLER: 36.2 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 3581.38 KW-H

AMOUNT: 12848 KM/YEAR

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		7870.72	6.126			
MOTOR COST		617.50	0.481			
CONTROLLER COST		1629.00	1.268			
EV TRANSMISSION COST		168.33	0.131			
BATTERY	LOW	3514.25	2.735	HIGH	4181.96	3.255
INITIAL COST	LOW	13799.80	10.741	HIGH	14467.51	11.261
DOWNPAYMENT	LOW	2759.96	2.148	HIGH	2893.50	2.252
REPLACEM'T BATTS	LOW	3514.25	2.735	HIGH	4181.96	3.255
REPAIRS & MAINTENANCE		2648.14	2.061			
REPLACEMENT TIRES		317.42	0.247			
INSURANCE		3479.00	2.708			
GARAGING,PARK, TOLL		782.50	0.609			
TITLE, REG, LIC,	LOW.	889.99	0.693	HIGH	923.38	0.719
ELECTRICITY		1790.69	1.394			
PRIN & INT	LOW	11039.84	8.593	HIGH	11574.01	9.008
OPERATING COST	LOW	24461.84	19.039	HIGH	25029.39	19.481
VEHICLE SALVAGE VALUE	LOW	2199.23	1.712	HIGH	2541.74	1.978
BATTERY SALVAGE	LOW	44.71	0.035	HIGH	44.71	0.035
TOTAL LIFE CYCLE COST	LOW	24977.85	19.441	HIGH	25336.44	19.720

ELECTRIC AND HYBRID VEHICLE COST MODEL

NA/S VAN 09-12-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: VAN
CURB WEIGHT: 1366 KG
VEHICLE WEIGHT , WT: 1661
LIFE: 128480 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 191 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .3098592

NAME: NA-S2.4
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.75

TRANSMISSION TYPE: fixed ratio

MOTOR --
RATED POWER: 30.4 KW
CONTROLLER: 33.7 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 3035.34 KW-H

AMOUNT: 12848 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	7676.44	5.975			
MOTOR COST	577.60	0.450			
CONTROLLER COST	1516.50	1.180			
EV TRANSMISSION COST	156.71	0.122			
BATTERY LOW	4302.99	3.349	HIGH	4529.46	3.525
INITIAL COST LOW	14230.23	11.076	HIGH	14456.71	11.252
DOWNPAYMENT LOW	2846.05	2.215	HIGH	2891.34	2.250
REPLACEM'T BATTS LOW	4302.99	3.349	HIGH	4529.46	3.525
REPAIRS & MAINTENANCE	3380.48	2.631			
REPLACEMENT TIRES	306.62	0.239			
INSURANCE	3479.00	2.708			
GARAGING, PARK, TOLL	782.50	0.609			
TITLE, REG, LIC, LOW.	911.51	0.709	HIGH	922.84	0.718
ELECTRICITY	1517.67	1.181			
PRIN & INT LOW	11384.19	8.861	HIGH	11565.37	9.002
OPERATING COST LOW	26064.95	20.287	HIGH	26257.45	20.437
VEHICLE SALVAGE VALUE LOW	877.68	0.683	HIGH	903.73	0.703
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	28033.31	21.819	HIGH	28245.06	21.984

ELECTRIC AND HYBRID VEHICLE COST MODEL

2 PAX BASELINE ICE 07-18-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 2-PASS
CURB WEIGHT: 500 KG
VEHICLE WEIGHT , WT: 636
LIFE: 118861 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 0 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: 1
MAINTENANCE FACTOR: 1

NAME: XX
BATTERY CYCLE LIFE: 1
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

ENGINE --
TANK CAPACITY: 40 L
ICE TRANSMISSION TYPE: CVT

FUEL COST: .373 $/L
FUEL TYPE: METHANOL
POWER: 19 KW

MOTOR --
RATED POWER: 0 KW
CONTROLLER: 0 KW
EV TRANSMISSION TYPE: fixed ratio

TYPE: AC

DRIVING --
ICE FRACTIONAL RANGE: 100 %
ANNUAL FUEL USE: 899 L

AMOUNT: 11886.1 KM/YEAR
EV FRACTIONAL RANGE: 0 %
ANNUAL ELEC USE: 0 KW-H

-- OUTPUTS --

COST ITEMS-

		$	C/KM		$	C/KM
BASIC VEHICLE COST		3261.51	2.744			
ENGINE COST		951.24	0.800			
ICE TRANSMISSION COST		212.23	0.179			
MOTOR COST		0.00	0.000			
CONTROLLER COST		0.00	0.000			
EV TRANSMISSION COST		0.00	0.000			
BATTERY	LOW	0.00	0.000	HIGH	0.00	0.000
INITIAL COST	LOW	4424.98	3.723	HIGH	4424.98	3.723
DOWNPAYMENT	LOW	885.00	0.745	HIGH	885.00	0.745
REPLACEM'T BATTS	LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE		4449.75	3.744			
REPLACEMENT TIRES		194.32	0.163			
INSURANCE		3479.00	2.927			
GARAGING, PARK, TOLL		782.50	0.658			
TITLE, REG, LIC,	LOW.	421.25	0.354	HIGH	421.25	0.354
FUEL-OIL		3453.87	2.906			
ELECTRICITY		0.00	0.000			
PRIN & INT	LOW	3539.99	2.978	HIGH	3539.99	2.978
OPERATING COST	LOW	16320.67	13.731	HIGH	16320.67	13.731
VEHICLE SALVAGE VALUE	LOW	170.60	0.144	HIGH	170.60	0.144
BATTERY SALVAGE	LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST	LOW	17035.07	14.332	HIGH	17035.07	14.332

ELECTRIC AND HYBRID VEHICLE COST MODEL

2 PAX PBAC2.1 80M ELEC 08-01-1984

--INPUTS--

GENERAL —
VEHICLE SIZE: 2-PASS
CURB WEIGHT: 935 KG
VEHICLE WEIGHT , WI: 1069
LIFE: 116661.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY —
BATTERY WEIGHT: 306 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2278544

NAME: PBAC/AD2.1
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1

TRANSMISSION TYPE: fixed ratio
MOTOR —
RATED POWER: 16.8 KW
CONTROLLER: 27.7 KW

TYPE: AC

DRIVING —
ANNUAL ELEC USE: 1531.046 KW-H

AMOUNT: 11886.19 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	4106.78	3.455			
MOTOR COST	319.20	0.269			
CONTROLLER COST	1246.50	1.049			
EV TRANSMISSION COST	126.61	0.108			
BATTERY LOW	1807.08	1.520	HIGH	2439.56	2.052
INITIAL COST LOW	7606.37	6.401	HIGH	8240.85	6.933
DOWNPAYMENT LOW	1521.67	1.280	HIGH	1648.17	1.387
REPLACEM'T BATTS LOW	1807.08	1.520	HIGH	2439.56	2.052
REPAIRS & MAINTENANCE	2172.33	1.828			
REPLACEMENT TIRES	227.47	0.191			
INSURANCE	3479.00	2.927			
GARAGING,PARK, TOLL	782.50	0.658			
TITLE, REG, LIC, LOW.	580.42	0.488	HIGH	612.04	0.515
ELECTRICITY	765.52	0.644			
PRIN & INT LOW	6086.69	5.121	HIGH	6592.68	5.547
OPERATING COST LOW	15901.01	13.378	HIGH	16438.62	13.830

VEHICLE SALVAGE VALUE LOW	1333.00	1.121	HIGH	1721.27	1.448
BATTERY SALVAGE LOW	21.84	0.018	HIGH	21.84	0.018
TOTAL LIFE CYCLE COST LOW	16067.84	13.518	HIGH	16343.67	13.750

ELECTRIC AND HYBRID VEHICLE COST MODEL

80-MI BIPOLAR 2-P EV 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 2-PASS
CURB WEIGHT: 808 KG
VEHICLE WEIGHT , WT: 944
LIFE: 118861.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 217 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2397297

NAME: PB-AC/BIPL
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS

DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: .5

TRANSMISSION TYPE: fixed ratio

MOTOR --
RATED POWER: 14.9 KW
CONTROLLER: 24.4 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 1213.591 KW-H

AMOUNT: 11886.19 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	3908.86	3.289			
MOTOR COST	283.10	0.238			
CONTROLLER COST	1098.00	0.924			
EV TRANSMISSION COST	113.46	0.095			
BATTERY LOW	1183.64	0.996	HIGH	1775.45	1.494
INITIAL COST LOW	6587.05	5.542	HIGH	7178.87	6.040
DOWNPAYMENT LOW	1317.41	1.108	HIGH	1435.77	1.208
REPLACEM'T BATTS LOW	1183.64	0.996	HIGH	1775.45	1.494
REPAIRS & MAINTENANCE	1494.81	1.258			
REPLACEMENT TIRES	217.90	0.183			
INSURANCE	3479.00	2.927			
GARAGING,PARK, TOLL	782.50	0.658			
TITLE, REG, LIC, LOW.	529.35	0.445	HIGH	558.94	0.470
ELECTRICITY	606.80	0.511			
PRIN & INT LOW	5269.64	4.433	HIGH	5743.10	4.832
OPERATING COST LOW	13563.64	11.411	HIGH	14066.69	11.834
VEHICLE SALVAGE VALUE LOW	849.44	0.715	HIGH	1169.99	0.984
BATTERY SALVAGE LOW	18.01	0.015	HIGH	18.01	0.015
TOTAL LIFE CYCLE COST LOW	14013.61	11.790	HIGH	14314.46	12.043

ELECTRIC AND HYBRID VEHICLE COST MODEL

2 PAX NIFE2.1 80M ELEC 08-01-1984

--INPUTS--

GENERAL --	YEAR: 1982
VEHICLE SIZE: 2-PASS	REAL INTEREST RATE: 10 %
CURB WEIGHT: 849 KG	VEHICLE SALVAGE VALUE: 10 %
VEHICLE WEIGHT , WT: 985	
LIFE: 118861.9 KM	ACCESSORY COST: $ 200
BATTERY --	NAME: NI-FE2.1
BATTERY WEIGHT: 246 KG	BATTERY CYCLE LIFE: 1500
ELECTRICITY COST: .05 $/KW-H	MAXIMUM SHELF LIFE: 10 YEARS
AVERAGE DAILY DEPTH OF DISCHARGE: .2077872	DEPTH OF A DEEP DISCHARGE: .8
MAINTENANCE FACTOR: 1.25	
TRANSMISSION TYPE: fixed ratio	
MOTOR --	
RATED POWER: 15.5 KW	TYPE: AC
CONTROLLER: 25.5 KW	
DRIVING --	AMOUNT: 11886.19 KM/YEAR
ANNUAL ELEC USE: 1990.135 KW-H	

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	3975.31	3.344			
MOTOR COST	294.50	0.248			
CONTROLLER COST	1147.50	0.965			
EV TRANSMISSION COST	118.58	0.100			
BATTERY LOW	3016.86	2.540	HIGH	3469.95	2.919
INITIAL COST LOW	8554.74	7.197	HIGH	9005.83	7.577
DOWNPAYMENT LOW	1710.95	1.439	HIGH	1801.17	1.515
REPLACEM T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	2511.08	2.113			
REPLACEMENT TIRES	221.04	0.186			
INSURANCE	3479.00	2.927			
GARAGING,PARK, TOLL	782.50	0.658			
TITLE, REG, LIC, LOW.	627.74	0.528	HIGH	650.29	0.547
ELECTRICITY	995.07	0.837			
PRIN & INT LOW	6843.79	5.758	HIGH	7204.67	6.061
OPERATING COST LOW	15460.22	13.007	HIGH	15843.65	13.329

VEHICLE SALVAGE VALUE LOW	213.43	0.180	HIGH	213.43	0.180
BATTERY SALVAGE LOW	87.14	0.073	HIGH	87.14	0.073
TOTAL LIFE CYCLE COST LOW	16870.59	14.193	HIGH	17344.24	14.592

ELECTRIC AND HYBRID VEHICLE COST MODEL

2 PAX NIZN2.0 8uM ELEC 08-01-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 2-PASS
CURB WEIGHT: 735 KG
VEHICLE WEIGHT , WT: 871
LIFE: 118861.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 165 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2414125

NAME: NI-ZN
BATTERY CYCLE LIFE: 600
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: .75

TRANSMISSION TYPE: fixed ratio

MOTOR --
RATED POWER: 13.7 KW
CONTROLLER: 22.6 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 1434.217 KW-H

AMOUNT: 11886.19 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	3793.74	3.192			
MOTOR COST	260.30	0.219			
CONTROLLER COST	1017.00	0.856			
EV TRANSMISSION COST	105.09	0.088			
BATTERY LOW	1579.50	1.329	HIGH	1737.45	1.462
	-------	------			
INITIAL COST LOW	6755.63	5.684	HIGH	6913.56	5.816
DOWNPAYMENT LOW	1351.13	1.137	HIGH	1382.72	1.163
REPLACEM'T BATTS LOW	1579.50	1.329	HIGH	1737.45	1.462
REPAIRS & MAINTENANCE	1833.57	1.543			
REPLACEMENT TIRES	212.31	0.179			
INSURANCE	3479.00	2.927			
GARAGING,PARK, TOLL	782.50	0.658			
TITLE, REG, LIC, LOW.	537.78	0.452	HIGH	545.68	0.459
ELECTRICITY	717.11	0.603			
PRIN & INT LOW	5404.51	4.547	HIGH	5530.87	4.653
	-------	------			
OPERATING COST LOW	14546.28	12.238	HIGH	14680.54	12.351
VEHICLE SALVAGE VALUE LOW	459.01	0.386	HIGH	484.95	0.408
BATTERY SALVAGE LOW	101.28	0.085	HIGH	101.28	0.085
TOTAL LIFE CYCLE COST LOW	15337.12	12.903	HIGH	15477.02	13.021

ELECTRIC AND HYBRID VEHICLE COST MODEL

80-MI ZN/BR 2-P EV 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 2-PASS
CURB WEIGHT: 969 KG
VEHICLE WEIGHT , WT: 1105
LIFE: 118861.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 332 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2350948

NAME: ZN-BR2/2.1
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio

MOTOR --
RATED POWER: 17.4 KW
CONTROLLER: 28.6 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 2820.304 KW-H

AMOUNT: 11886.19 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM		$	C/KM
BASIC VEHICLE COST	4160.87	3.501			
MOTOR COST	330.60	0.278			
CONTROLLER COST	1287.00	1.083			
EV TRANSMISSION COST	132.99	0.112			
BATTERY LOW	1909.80	1.607	HIGH	3857.80	3.246
INITIAL COST LOW	7821.26	6.580	HIGH	9769.25	8.219
DOWNPAYMENT LOW	1564.25	1.316	HIGH	1953.85	1.644
REPLACEM'T BATTS LOW	1909.80	1.607	HIGH	3857.80	3.246
REPAIRS & MAINTENANCE	3527.35	2.968			
REPLACEMENT TIRES	230.23	0.194			
INSURANCE	3479.00	2.927			
GARAGING,PARK, TOLL	782.50	0.658			
TITLE, REG, LIC, LOW.	591.06	0.497	HIGH	688.46	0.579
ELECTRICITY	1410.15	1.186			
PRIN & INT LOW	6257.01	5.264	HIGH	7815.40	6.575
OPERATING COST LOW	18187.10	15.301	HIGH	19842.90	16.694
VEHICLE SALVAGE VALUE LOW	1316.19	1.107	HIGH	2426.24	2.041
BATTERY SALVAGE LOW	31.87	0.027	HIGH	31.87	0.027
TOTAL LIFE CYCLE COST LOW	18403.29	15.483	HIGH	19338.64	16.270

ELECTRIC AND HYBRID VEHICLE COST MODEL

80-MI ZN/CL 2-P EV 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 2-PASS
CURB WEIGHT: 878 KG
VEHICLE WEIGHT , WT: 1014
LIFE: 118861.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 267 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2033406

NAME: ZN-CL2/2.1
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 16 KW
CONTROLLER: 26.3 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 2341.186 KW-H

AMOUNT: 11886.19 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	4017.68	3.380			
MOTOR COST	304.00	0.256			
CONTROLLER COST	1183.50	0.996			
EV TRANSMISSION COST	122.30	0.103			
BATTERY LOW	3567.04	3.001	HIGH	3709.72	3.121
INITIAL COST LOW	9194.51	7.735	HIGH	9337.19	7.855
DOWNPAYMENT LOW	1838.90	1.547	HIGH	1867.44	1.571
REPLACEM'T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	3527.35	2.968			
REPLACEMENT TIRES	223.26	0.188			
INSURANCE	3479.00	2.927			
GARAGING,PARK, TOLL	782.50	0.658			
TITLE, REG, LIC, LOW.	659.73	0.555	HIGH	666.86	0.561
ELECTRICITY	1170.59	0.985			
PRIN & INT LOW	7355.61	6.188	HIGH	7469.75	6.284
OPERATING COST LOW	17198.04	14.469	HIGH	17319.32	14.571
VEHICLE SALVAGE VALUE LOW	216.96	0.183	HIGH	216.96	0.183
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	18819.98	15.833	HIGH	18969.79	15.960

ELECTRIC AND HYBRID VEHICLE COST MODEL

2 PAX FEAIR2.1 80M ELEC 01-01-1980

--INPUTS--

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 GENERAL --                                 YEAR:       1982
VEHICLE SIZE:  2-PASS                       REAL INTEREST RATE:   10 %
CURB WEIGHT:  788 KG                        VEHICLE SALVAGE VALUE:    10 %
VEHICLE WEIGHT , WT:   924
LIFE:              118861.9 KM              ACCESSORY COST:   $ 200

 BATTERY --                                 NAME:   FE-AIR2.1
BATTERY WEIGHT:    203 KG                   BATTERY CYCLE LIFE:   500
ELECTRICITY COST:    .05 $/KW-H             MAXIMUM SHELF LIFE:   10 YEARS
AVERAGE DAILY DEPTH OF DISCHARGE:  .2219855
                                            DEPTH OF A DEEP DISCHARGE:  .8
MAINTENANCE FACTOR:   2

TRANSMISSION TYPE:  fixed ratio
 MOTOR --
RATED POWER:         14.6 KW                TYPE:        AC
CONTROLLER:        23.9  KW

 DRIVING --                                 AMOUNT:    11886.19 KM/YEAR
ANNUAL ELEC USE:    2550.864 KW-H
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-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		3875.25	3.260			
MOTOR COST		277.40	0.233			
CONTROLLER COST		1075.50	0.905			
EV TRANSMISSION COST		111.14	0.093			
BATTERY	LOW	2074.00	1.745	HIGH	5330.18	4.484
		-------	------			
INITIAL COST	LOW	7413.28	6.237	HIGH	10669.46	8.976
DOWNPAYMENT	LOW	1482.66	1.247	HIGH	2133.89	1.795
REPLACEM'T BATTS	LOW	4148.00	3.490	HIGH	10660.35	8.969
REPAIRS & MAINTENANCE		3527.35	2.968			
REPLACEMENT TIRES		216.37	0.182			
INSURANCE		3479.00	2.927			
GARAGING,PARK, TOLL		782.50	0.658			
TITLE, REG, LIC,	LOW.	570.66	0.480	HIGH	733.47	0.617
ELECTRICITY		1275.43	1.073			
PRIN & INT	LOW	5930.63	4.990	HIGH	8535.57	7.181
		-------	------			
OPERATING COST	LOW	19929.94	16.767	HIGH	22697.69	19.096
VEHICLE SALVAGE VALUE	LOW	2226.72	1.873	HIGH	5399.48	4.543
BATTERY SALVAGE	LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST	LOW	19185.88	16.141	HIGH	19432.10	16.348

ELECTRIC AND HYBRID VEHICLE COST MODEL

80-MI LI/FES 2-P EV 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 2-PASS
CURB WEIGHT: 743 KG
VEHICLE WEIGHT , WI: 879
LIFE: 118861.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 171 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .1917694

NAME: LI-FE-S2.1
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.25

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 13.9 KW
CONTROLLER: 22.8 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 1716.726 KW-H

AMOUNT: 11886.19 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	3803.27	3.200			
MOTOR COST	264.10	0.222			
CONTROLLER COST	1026.00	0.863			
EV TRANSMISSION COST	106.02	0.089			
BATTERY LOW	2538.55	2.136	HIGH	2729.62	2.296
INITIAL COST LOW	7737.94	6.510	HIGH	7929.01	6.671
DOWNPAYMENT LOW	1547.59	1.302	HIGH	1585.80	1.334
REPLACEM'T BATTS LOW	2538.55	2.136	HIGH	2729.62	2.296
REPAIRS & MAINTENANCE	2511.08	2.113			
REPLACEMENT TIRES	212.93	0.179			
INSURANCE	3479.00	2.927			
GARAGING,PARK, TOLL	782.50	0.658			
TITLE, REG, LIC, LOW.	586.90	0.494	HIGH	596.45	0.502
ELECTRICITY	858.36	0.722			
PRIN & INT LOW	6190.35	5.208	HIGH	6343.21	5.337
OPERATING COST LOW	17159.66	14.437	HIGH	17322.07	14.573
VEHICLE SALVAGE VALUE LOW	2316.09	1.949	HIGH	2475.33	2.083
BATTERY SALVAGE LOW	27.70	0.023	HIGH	27.70	0.023
TOTAL LIFE CYCLE COST LOW	16363.46	13.767	HIGH	16404.84	13.802

ELECTRIC AND HYBRID VEHICLE COST MODEL

2 PAX NAS2.1 80M ELEC 01-01-1980

--INPUTS--

GENERAL —
VEHICLE SIZE: 2-PASS
CURB WEIGHT: 667 KG
VEHICLE WEIGHT , WT: 803
LIFE: 118861.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY —
BATTERY WEIGHT: 118 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2363671

NAME: NA-S2.1
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.75

TRANSMISSION TYPE: fixed ratio
MOTOR —
RATED POWER: 12.7 KW
CONTROLLER: 20.8 KW

TYPE: AC

DRIVING —
ANNUAL ELEC USE: 1453.32 KW-H

AMOUNT: 11886.19 KM/YEAR

— OUTPUTS —

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	3675.79	3.092			
MOTOR COST	241.30	0.203			
CONTROLLER COST	936.00	0.787			
EV TRANSMISSION COST	96.72	0.081			
BATTERY LOW	3154.55	2.654	HIGH	3911.65	3.291
INITIAL COST LOW	8104.36	6.818	HIGH	8861.46	7.455
DOWNPAYMENT LOW	1620.87	1.364	HIGH	1772.29	1.491
REPLACEM'T BATTS LOW	3154.55	2.654	HIGH	3911.65	3.291
REPAIRS & MAINTENANCE	3188.59	2.683			
REPLACEMENT TIRES	207.11	0.174			
INSURANCE	3479.00	2.927			
GARAGING,PARK, TOLL	782.50	0.658			
TITLE, REG, LIC, LOW.	605.22	0.509	HIGH	643.07	0.541
ELECTRICITY	726.66	0.611			
PRIN & INT LOW	6483.49	5.455	HIGH	7089.17	5.964
OPERATING COST LOW	18627.13	15.671	HIGH	19270.66	16.213
VEHICLE SALVAGE VALUE LOW	1963.63	1.652	HIGH	2389.10	2.010
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	18284.37	15.383	HIGH	18653.85	15.694

ELECTRIC AND HYBRID VEHICLE COST MODEL

5 PAX BASELINE ICE 100M 1992 07-18-1984

—INPUTS—

GENERAL —
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 895 KG
VEHICLE WEIGHT , WT: 1031
LIFE: 132365.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY —
BATTERY WEIGHT: 0 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .11
MAINTENANCE FACTOR: 1

NAME: XXX
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

ENGINE —
TANK CAPACITY: 40 L
ICE TRANSMISSION TYPE: CVT

FUEL COST: .373 $/L
FUEL TYPE: METHANOL
POWER: 31 KW

MOTOR —
RATED POWER: 0 KW
CONTROLLER: 0 KW
EV TRANSMISSION TYPE: fixed ratio

TYPE: AC

DRIVING —
ICE FRACTIONAL RANGE: 100 %
ANNUAL FUEL USE: 1302 L

AMOUNT: 13236.59 KM/YEAR
EV FRACTIONAL RANGE: 0 %
ANNUAL ELEC USE: 0 KW-H

— OUTPUTS —

COST ITEMS-

		$	C/KM		$	C/KM
BASIC VEHICLE COST		5745.61	4.341			
ENGINE COST		1118.03	0.845			
ICE TRANSMISSION COST		346.27	0.262			
MOTOR COST		0.00	0.000			
CONTROLLER COST		0.00	0.000			
EV TRANSMISSION COST		0.00	0.000			
BATTERY	LOW	0.00	0.000	HIGH	0.00	0.000
INITIAL COST	LOW	7209.90	5.447	HIGH	7209.90	5.447
DOWNPAYMENT	LOW	1441.98	1.089	HIGH	1441.98	1.089
REPLACEM'T BATTS	LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE		4707.69	3.557			
REPLACEMENT TIRES		280.22	0.212			
INSURANCE		3479.00	2.628			
GARAGING,PARK, TOLL		782.50	0.591			
TITLE, REG, LIC,	LOW.	560.50	0.423	HIGH	560.50	0.423
FUEL-OIL		5002.15	3.779			
ELECTRICITY		0.00	0.000			
PRIN & INT	LOW	5767.92	4.358	HIGH	5767.92	4.358
OPERATING COST	LOW	20579.98	15.548	HIGH	20579.98	15.548
VEHICLE SALVAGE VALUE	LOW	277.97	0.210	HIGH	277.97	0.210
BATTERY SALVAGE	LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST	LOW	21743.98	16.427	HIGH	21743.98	16.427

ELECTRIC AND HYBRID VEHICLE COST MODEL

5 PAX FBAC2.4 100M ELEC 06-01-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1768 KG
VEHICLE WEIGHT , WT: 1904
LIFE: 132365.9 KM

YEAR: 1982
REAL INTEREST RATE. 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT. 590 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2124069

NAME: FBAC/AD2.4
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 48 KW
CONTROLLER: 53 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 2771.213 KW-H

AMOUNT: 13236.59 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM		
BASIC VEHICLE COST	7299.54	5.515		
MOTOR COST	912.00	0.689		
CONTROLLER COST	2385.00	1.802		
EV TRANSMISSION COST	246.45	0.186		
BATTERY LOW	2906.81	2.198	HIGH 3490.57	2.637
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INITIAL COST LOW	13751.80	10.389	HIGH14333.56	10.829
DOWNPAYMENT LOW	2750.36	2.078	HIGH 2866.71	2.166
REPLACEM T BATTS LOW	2906.81	2.198	HIGH 3490.57	2.637
REPAIRS & MAINTENANCE	2326.27	1.757		
REPLACEMENT TIRES	363.60	0.275		
INSURANCE	3479.00	2.628		
GARAGING,PARK, TOLL	782.50	0.591		
TITLE, REG, LIC, LOW.	887.59	0.671	HIGH 916.68	0.693
ELECTRICITY	1385.61	1.047		
PRIN & INT LOW	11001.44	8.311	HIGH11466.85	8.663
	-------	------		
OPERATING COST LOW	23134.81	17.478	HIGH23629.31	17.852
VEHICLE SALVAGE VALUE LOW	2477.07	1.871	HIGH 2888.87	2.182
BATTERY SALVAGE LOW	40.16	0.030	HIGH 40.16	0.030
TOTAL LIFE CYCLE COST LOW	23367.95	17.654	HIGH23567.00	17.804

ELECTRIC AND HYBRID VEHICLE COST MODEL

100-MI BIPOLAR 5-P EV 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1498 KG
VEHICLE WEIGHT , WT: 1634
LIFE: 131434.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 404 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2217449

NAME: PB-AC/BIPL
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: .5

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 41.2 KW
CONTROLLER: 45.7 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 2128.121 KW-H

AMOUNT: 13143.49 KM/YEAR

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		6868.21	5.226			
MOTOR COST		782.80	0.596			
CONTROLLER COST		2056.50	1.565			
EV TRANSMISSION COST		212.51	0.162			
BATTERY	LOW	2203.64	1.677	HIGH	3305.45	2.515
INITIAL COST	LOW	12123.65	9.224	HIGH	13225.47	10.062
DOWNPAYMENT	LOW	2424.73	1.845	HIGH	2645.09	2.012
REPLACEM'T BATTS	LOW	2203.64	1.677	HIGH	3305.45	2.515
REPAIRS & MAINTENANCE		1566.48	1.192			
REPLACEMENT TIRES		333.18	0.253			
INSURANCE		3479.00	2.647			
GARAGING,PARK, TOLL		782.50	0.595			
TITLE, REG, LIC,	LOW.	806.18	0.613	HIGH	861.27	0.655
ELECTRICITY		1064.06	0.810			
PRIN & INT	LOW	9698.92	7.379	HIGH	10580.38	8.050
OPERATING COST	LOW	19933.97	15.166	HIGH	20870.51	15.879
VEHICLE SALVAGE VALUE	LOW	1817.14	1.383	HIGH	2534.48	1.928
BATTERY SALVAGE	LOW	33.53	0.026	HIGH	33.53	0.026
TOTAL LIFE CYCLE COST	LOW	20508.02	15.603	HIGH	20947.59	15.938

ELECTRIC AND HYBRID VEHICLE COST MODEL

5 PAX NIFE2.4 100M ELEC 08-01-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1545 KG
VEHICLE WEIGHT , WT: 1681
LIFE: 132365.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 437 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2075506

NAME: NI-FE2.4
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.25

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 42.4 KW
CONTROLLER: 47 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 3480.456 KW-H

AMOUNT: 13236.59 KM/YEAR

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		6938.52	5.242			
MOTOR COST		805.60	0.609			
CONTROLLER COST		2115.00	1.598			
EV TRANSMISSION COST		218.55	0.165			
BATTERY	LOW	4676.12	3.534	HIGH	5197.91	3.927
INITIAL COST	LOW	14755.79	11.148	HIGH	15275.58	11.540
DOWNPAYMENT	LOW	2951.16	2.230	HIGH	3055.12	2.308
REPLACEM T BATTS	LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE		2703.51	2.042			
REPLACEMENT TIRES		342.30	0.259			
INSURANCE		3479.00	2.628			
GARAGING,PARK, TOLL		782.50	0.591			
TITLE, REG, LIC,	LOW.	937.79	0.708	HIGH	963.78	0.728
ELECTRICITY		1740.23	1.315			
PRIN & INT	LOW	11804.63	8.916	HIGH	12220.47	9.232
OPERATING COST	LOW	21789.96	16.462	HIGH	22231.79	16.796
VEHICLE SALVAGE VALUE	LOW	388.54	0.294	HIGH	388.54	0.294
BATTERY SALVAGE	LOW	149.07	0.113	HIGH	149.07	0.113
TOTAL LIFE CYCLE COST	LOW	24203.51	18.285	HIGH	24749.30	18.698

ELECTRIC AND HYBRID VEHICLE COST MODEL

5 PAX NIZN2.0 100M ELEC 08-01-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1399 KG
VEHICLE WEIGHT , WT: 1535
LIFE: 132365.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 336 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2042647

NAME: NI-FE2.4
BATTERY CYCLE LIFE: 600
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: .75

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 36.7 KW
CONTROLLER: 43 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 2546.371 KW-H

AMOUNT: 13236.59 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM		
BASIC VEHICLE COST	6706.94	5.068		
MOTOR COST	735.30	0.556		
CONTROLLER COST	1935.00	1.462		
EV TRANSMISSION COST	199.95	0.151		
BATTERY LOW	3823.83	2.889	HIGH 4248.70	3.210
INITIAL COST LOW	13403.02	10.126	HIGH13827.89	10.447
DOWNPAYMENT LOW	2680.60	2.025	HIGH 2765.58	2.089
REPLACEM'T BATTS LOW	3823.83	2.889	HIGH 4246.70	3.210
REPAIRS & MAINTENANCE	1949.03	1.472		
REPLACEMENT TIRES	328.35	0.248		
INSURANCE	3479.00	2.628		
GARAGING,PARK, TOLL	782.50	0.591		
TITLE, REG, LIC, LOW.	870.15	0.657	HIGH 891.39	0.673
ELECTRICITY	1273.19	0.962		
PRIN & INT LOW	10722.42	8.101	HIGH11062.32	8.357
OPERATING COST LOW	23228.47	17.549	HIGH23589.61	17.822
VEHICLE SALVAGE VALUE LOW	2076.98	1.569	HIGH 2266.72	1.712
BATTERY SALVAGE LOW	114.62	0.087	HIGH 114.62	0.087
TOTAL LIFE CYCLE COST LOW	23717.48	17.918	HIGH23973.85	18.112

ELECTRIC AND HYBRID VEHICLE COST MODEL

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                              100-MI ZN/BR 5-P EV        08-29-1984

                                 *--INPUTS--*

 GENERAL --                            YEAR:      1982
VEHICLE SIZE:  5-PASS                  REAL INTEREST RATE:   10 %
CURB WEIGHT:  1700 KG                  VEHICLE SALVAGE VALUE:     10 %
VEHICLE WEIGHT , WT:   1836
LIFE:             132365.9 KM          ACCESSORY COST:   $ 200

 BATTERY --                            NAME:   ZN-BR2/2.4
BATTERY WEIGHT:     544 KG             BATTERY CYCLE LIFE:   750
ELECTRICITY COST:     .05 $/KW-H       MAXIMUM SHELF LIFE:    10 YEARS
AVERAGE DAILY DEPTH OF DISCHARGE:  .2387005
                                       DEPTH OF A DEEP DISCHARGE:  .8
MAINTENANCE FACTOR:   2

TRANSMISSION TYPE:  fixed ratio
 MOTOR --
RATED POWER:          46.3 KW          TYPE:         AC
CONTROLLER:       51.4  KW

 DRIVING --                            AMOUNT:    13236.59 KM/YEAR
ANNUAL ELEC USE:    4842.51 KW-H

                              *-- OUTPUTS --*

COST ITEMS-
                                $     C/KM
BASIC VEHICLE COST          7183.03  5.427
MOTOR COST                   879.70  0.665
CONTROLLER COST             2313.00  1.747
EV TRANSMISSION COST         239.01  0.181
BATTERY      LOW            2682.98  2.027   HIGH 4614.73  3.486
                            -------  -----
INITIAL COST      LOW      13297.73 10.046   HIGH15229.47 11.506
DOWNPAYMENT    LOW          2659.55  2.009   HIGH 3045.89  2.301


REPLACEM'T BATTS LOW        2682.98  2.027   HIGH 4614.73  3.486
REPAIRS & MAINTENANCE       3835.24  2.897
REPLACEMENT TIRES            357.10  0.270
INSURANCE                   3479.00  2.628
GARAGING,PARK, TOLL          782.50  0.591
TITLE, REG, LIC, LOW.        864.89  0.653   HIGH  961.47  0.726
ELECTRICITY                 2421.26  1.829
PRIN & INT LOW             10638.18  8.037   HIGH12183.58  9.204
                           --------  -----
OPERATING COST  LOW        25061.15 18.933   HIGH26703.13 20.174


VEHICLE SALVAGE VALUE  LOW 1879.26  1.420   HIGH 2937.68  2.219
BATTERY SALVAGE  LOW          53.31  0.040   HIGH   53.31  0.040


TOTAL LIFE CYCLE COST  LOW25788.12 19.482   HIGH26758.04 20.215
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ELECTRIC AND HYBRID VEHICLE COST MODEL

100-MI ZN/CL 5-P EV   08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1499 KG
VEHICLE WEIGHT , WT: 1635
LIFE: 132365.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 406 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2203587

NAME: ZN-CL2/2.4
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 41.2 KW
CONTROLLER: 45.8 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 3909.403 KW-H

AMOUNT: 13236.59 KM/YEAR

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		6860.50	5.183			
MOTOR COST		782.80	0.591			
CONTROLLER COST		2061.00	1.557			
EV TRANSMISSION COST		212.97	0.161			
BATTERY	LOW	5031.18	3.801	HIGH	5232.42	3.953
INITIAL COST	LOW	14948.44	11.293	HIGH	15149.69	11.445
DOWNPAYMENT	LOW	2989.69	2.259	HIGH	3029.94	2.289
REPLACEM'T BATTS	LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE		3835.24	2.897			
REPLACEMENT TIRES		337.90	0.255			
INSURANCE		3479.00	2.628			
GARAGING,PARK, TOLL		782.50	0.591			
TITLE, REG, LIC,	LOW.	947.42	0.716	HIGH	957.48	0.723
ELECTRICITY		1954.70	1.477			
PRIN & INT	LOW	11958.76	9.035	HIGH	12119.75	9.156
OPERATING COST	LOW	23295.53	17.599	HIGH	23466.59	17.729
VEHICLE SALVAGE VALUE	LOW	382.35	0.289	HIGH	382.35	0.289
BATTERY SALVAGE	LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST	LOW	25902.86	19.569	HIGH	26114.17	19.729

ELECTRIC AND HYBRID VEHICLE COST MODEL

5 PAX FEAIR2.4 100M ELEC 01-01-1980

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1401 KG
VEHICLE WEIGHT , WT: 1537
LIFE: 132365.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 338 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2255741
MAINTENANCE FACTOR: 2

NAME: FE-AIR2.4
BATTERY CYCLE LIFE: 500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

TRANSMISSION TYPE: fixed ratio

MOTOR --
RATED POWER: 38.7 KW
CONTROLLER: 43 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 4367.761 KW-H

AMOUNT: 13236.59 KM/YEAR

-- OUTPUTS --

COST ITEMS-

		$	C/KM		$	C/KM
BASIC VEHICLE COST		6708.94	5.068			
MOTOR COST		735.30	0.556			
CONTROLLER COST		1935.00	1.462			
EV TRANSMISSION COST		199.95	0.151			
BATTERY	LOW	3014.35	2.277	HIGH	5516.26	4.167
		-------	------			
INITIAL COST	LOW	12593.54	9.514	HIGH	15095.45	11.404
DOWNPAYMENT	LOW	2518.71	1.903	HIGH	3019.09	2.281
REPLACEM'T BATTS	LOW	6028.70	4.555	HIGH	11032.52	8.335
REPAIRS & MAINTENANCE		3835.24	2.897			
REPLACEMENT TIRES		328.54	0.248			
INSURANCE		3479.00	2.628			
GARAGING,PARK, TOLL		782.50	0.591			
TITLE, REG, LIC,	LOW.	829.68	0.627	HIGH	954.77	0.721
ELECTRICITY		2183.88	1.650			
PRIN & INT	LOW	10074.83	7.611	HIGH	12076.36	9.123
		-------	------			
OPERATING COST	LOW	27542.37	20.808	HIGH	29669.00	22.414
VEHICLE SALVAGE VALUE	LOW	3207.74	2.423	HIGH	5563.63	4.203
BATTERY SALVAGE	LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST	LOW	26853.35	20.287	HIGH	27124.46	20.492

ELECTRIC AND HYBRID VEHICLE COST MODEL

100-MI LI/FES 5-P EV 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1369 KG
VEHICLE WEIGHT , WT: 1505
LIFE: 132365.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 316 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .174862

NAME: LI-FE-S2.4
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.25

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 37.9 KW
CONTROLLER: 42.1 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 2988.141 KW-H

AMOUNT: 13236.59 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	6657.70	5.030			
MOTOR COST	720.10	0.544			
CONTROLLER COST	1894.50	1.431			
EV TRANSMISSION COST	195.77	0.148			
BATTERY LOW	3875.35	2.928	HIGH	4611.66	3.484
INITIAL COST LOW	13343.41	10.081	HIGH	14079.72	10.637
DOWNPAYMENT LOW	2668.68	2.016	HIGH	2815.94	2.127
REPLACEM'T BATTS LOW	3875.35	2.928	HIGH	4611.66	3.484
REPAIRS & MAINTENANCE	2703.51	2.042			
REPLACEMENT TIRES	325.49	0.246			
INSURANCE	3479.00	2.628			
GARAGING,PARK, TOLL	782.50	0.591			
TITLE, REG, LIC, LOW.	867.17	0.655	HIGH	903.99	0.683
ELECTRICITY	1494.07	1.129			
PRIN & INT LOW	10674.73	8.065	HIGH	11263.78	8.510
OPERATING COST LOW	24201.81	18.284	HIGH	24827.68	18.757
VEHICLE SALVAGE VALUE LOW	3993.35	3.017	HIGH	4682.73	3.538
BATTERY SALVAGE LOW	51.19	0.039	HIGH	51.19	0.039
TOTAL LIFE CYCLE COST LOW	22825.95	17.245	HIGH	22909.71	17.308

ELECTRIC AND HYBRID VEHICLE COST MODEL

5 PAX NAS2.4 100M ELEC   01-01-1980

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1266 KG
VEHICLE WEIGHT , WT: 1402
LIFE: 132365.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 245 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2005257

NAME: NA-S2.4
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.75

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 35.3 KW
CONTROLLER: 39.3 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 2549.627 KW-H

AMOUNT: 13236.59 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	6493.66	4.906			
MOTOR COST	670.70	0.507			
CONTROLLER COST	1768.50	1.336			
EV TRANSMISSION COST	182.75	0.138			
BATTERY LOW	5153.29	3.893	HIGH	5424.51	4.098
	-------	------			
INITIAL COST LOW	14268.90	10.780	HIGH	14540.12	10.985
DOWNPAYMENT LOW	2853.78	2.156	HIGH	2908.02	2.197
REPLACEM'T BATTS LOW	5153.29	3.893	HIGH	5424.51	4.098
REPAIRS & MAINTENANCE	3458.00	2.612			
REPLACEMENT TIRES	315.65	0.238			
INSURANCE	3479.00	2.628			
GARAGING,PARK, TOLL	782.50	0.591			
TITLE, REG, LIC, LOW.	913.44	0.690	HIGH	927.01	0.700
ELECTRICITY	1274.81	0.963			
PRIN & INT LOW	11415.12	8.624	HIGH	11632.10	8.788
	--------	------			
OPERATING COST LOW	26791.81	20.241	HIGH	27022.35	20.415
VEHICLE SALVAGE VALUE LOW	4369.83	3.301	HIGH	4531.32	3.461
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	25273.76	19.095	HIGH	25349.06	19.151

ELECTRIC AND HYBRID VEHICLE COST MODEL

5 PAX BASELINE ICE 150M ELEC 07-18-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 895 KG
VEHICLE WEIGHT , WT: 1031
LIFE: 150110 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 0 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .11
MAINTENANCE FACTOR: 1

NAME: XXX
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

ENGINE --
TANK CAPACITY: 40 L
ICE TRANSMISSION TYPE: CVT

FUEL COST: .373 $/L
FUEL TYPE: METHANOL
POWER: 31 KW

MOTOR --
RATED POWER: 0 KW
CONTROLLER: 0 KW
EV TRANSMISSION TYPE: fixed ratio

TYPE: AC

DRIVING --
ICE FRACTIONAL RANGE: 100 %
ANNUAL FUEL USE: 1511 L

AMOUNT: 15011 KM/YEAR
EV FRACTIONAL RANGE: 0 %
ANNUAL ELEC USE: 0 KW-H

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	5745.61	3.828			
ENGINE COST	1118.03	0.745			
ICE TRANSMISSION COST	346.27	0.231			
MOTOR COST	0.00	0.000			
CONTROLLER COST	0.00	0.000			
EV TRANSMISSION COST	0.00	0.000			
BATTERY LOW	0.00	0.000	HIGH	0.00	0.000
INITIAL COST LOW	7209.90	4.803	HIGH	7209.90	4.803
DOWNPAYMENT LOW	1441.98	0.961	HIGH	1441.98	0.961
REPLACEM'T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	5175.05	3.448			
REPLACEMENT TIRES	353.34	0.235			
INSURANCE	3479.00	2.318			
GARAGING, PARK, TOLL	782.50	0.521			
TITLE, REG, LIC, LOW.	560.50	0.373	HIGH	560.50	0.373
FUEL-OIL	5805.11	3.867			
ELECTRICITY	0.00	0.000			
PRIN & INT LOW	5767.92	3.842	HIGH	5767.92	3.842
OPERATING COST LOW	21923.43	14.605	HIGH	21923.43	14.605
VEHICLE SALVAGE VALUE LOW	277.97	0.185	HIGH	277.97	0.185
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	23087.44	15.380	HIGH	23087.44	15.380

ELECTRIC AND HYBRID VEHICLE COST MODEL

5 PAX PBAC2.4 150M ELEC 08-08-1984

—INPUTS—

GENERAL —	YEAR: 1982
VEHICLE SIZE: 5-PASS	REAL INTEREST RATE: 10 %
CURB WEIGHT: 2366 KG	VEHICLE SALVAGE VALUE: 10 %
VEHICLE WEIGHT , WI: 2502	
LIFE: 150106.7 KM	ACCESSORY COST: $ 200
BATTERY —	NAME: PBAC/AD2.4
BATTERY WEIGHT: 1001 KG	BATTERY CYCLE LIFE: 750
ELECTRICITY COST: .05 $/KW-H	MAXIMUM SHELF LIFE: 10 YEARS
AVERAGE DAILY DEPTH OF DISCHARGE: .1667522	
	DEPTH OF A DEEP DISCHARGE: .8
MAINTENANCE FACTOR: 1	
TRANSMISSION TYPE: fixed ratio	
MOTOR —	
RATED POWER: 63 KW	TYPE: AC
CONTROLLER: 70 KW	
DRIVING —	AMOUNT: 15010.67 KM/YEAR
ANNUAL ELEC USE: 3862.698 KW-H	

— OUTPUTS —

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	8255.97	5.500			
MOTOR COST	1197.00	0.797			
CONTROLLER COST	3150.00	2.099			
EV TRANSMISSION COST	325.50	0.217			
BATTERY LOW	4555.14	3.035	HIGH	5466.17	3.642
INITIAL COST LOW	17483.62	11.647	HIGH	18394.65	12.254
DOWNPAYMENT LOW	3496.72	2.329	HIGH	3678.93	2.451
REPLACEM'T BATTS LOW	4555.14	3.035	HIGH	5466.17	3.642
REPAIRS & MAINTENANCE	2633.01	1.754			
REPLACEMENT TIRES	530.49	0.353			
INSURANCE	3479.00	2.318			
GARAGING,PARK, TOLL	782.50	0.521			
TITLE, REG, LIC, LOW.	1074.18	0.716	HIGH	1119.73	0.746
ELECTRICITY	1931.35	1.287			
PRIN & INT LOW	13986.89	9.318	HIGH	14715.72	9.804
OPERATING COST LOW	28972.57	19.301	HIGH	29746.94	19.817
VEHICLE SALVAGE VALUE LOW	4987.95	3.323	HIGH	5885.86	3.921
BATTERY SALVAGE LOW	68.13	0.045	HIGH	68.13	0.045
TOTAL LIFE CYCLE COST LOW	27413.21	18.262	HIGH	27471.88	18.302

ELECTRIC AND HYBRID VEHICLE COST MODEL

150-MI BIPOLAR 5-P EV 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 2007 KG
VEHICLE WEIGHT , WT: 2143
LIFE: 150106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 754 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .1606102

NAME: PB-AC/BIPL
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS

DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: .5

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 54 KW
CONTROLLER: 60 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 2950.161 KW-H

AMOUNT: 15010.67 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	7681.97	5.118			
MOTOR COST	1026.00	0.684			
CONTROLLER COST	2700.00	1.799			
EV TRANSMISSION COST	279.00	0.186			
BATTERY LOW	4112.73	2.740	HIGH	6169.09	4.110
INITIAL COST LOW	15799.70	10.526	HIGH	17856.06	11.896
DOWNPAYMENT LOW	3159.94	2.105	HIGH	3571.21	2.379
REPLACEM'T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	1709.86	1.139			
REPLACEMENT TIRES	487.25	0.325			
INSURANCE	3479.00	2.318			
GARAGING,PARK, TOLL	782.50	0.521			
TITLE, REG, LIC, LOW.	989.98	0.660	HIGH	1092.80	0.728
ELECTRICITY	1475.08	0.983			
PRIN & INT LOW	12639.76	8.421	HIGH	14284.85	9.516
OPERATING COST LOW	21563.43	14.365	HIGH	23311.35	15.530
VEHICLE SALVAGE VALUE LOW	450.58	0.300	HIGH	450.58	0.300
BATTERY SALVAGE LOW	62.58	0.042	HIGH	62.58	0.042
TOTAL LIFE CYCLE COST LOW	24210.21	16.129	HIGH	26369.39	17.567

ELECTRIC AND HYBRID VEHICLE COST MODEL

5 PAX NIFE2.4 150M ELEC 01-01-1980

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1875 KG
VEHICLE WEIGHT , WT: 2011
LIFE: 150106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 664 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .1729227
MAINTENANCE FACTOR: 1.25

NAME: NI-FE2.4
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

TRANSMISSION TYPE: fixed ratio

MOTOR --
RATED POWER: 50.7 KW
CONTROLLER: 56.3 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 4520.326 KW-H

AMOUNT: 15010.67 KM/YEAR

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		7465.27	4.973			
MOTOR COST		963.30	0.642			
CONTROLLER COST		2533.50	1.688			
EV TRANSMISSION COST		261.79	0.174			
BATTERY	LOW	6598.17	4.396	HIGH	7331.30	4.884
		--------	------			
INITIAL COST	LOW	17822.04	11.873	HIGH	18555.17	12.361
DOWNPAYMENT	LOW	3564.41	2.375	HIGH	3711.03	2.472
REPLACEM'T BATTS	LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE		3094.59	2.062			
REPLACEMENT TIRES		471.36	0.314			
INSURANCE		3479.00	2.318			
GARAGING,PARK, TOLL		782.50	0.521			
TITLE, REG, LIC,	LOW.	1091.10	0.727	HIGH	1127.76	0.751
ELECTRICITY		2260.16	1.506			
PRIN & INT	LOW	14257.63	9.498	HIGH	14844.13	9.889
		-------	------			
OPERATING COST	LOW	25436.34	16.946	HIGH	26059.50	17.361
VEHICLE SALVAGE VALUE	LOW	432.73	0.288	HIGH	432.73	0.288
BATTERY SALVAGE	LOW	226.50	0.151	HIGH	226.50	0.151
TOTAL LIFE CYCLE COST	LOW	28341.52	18.881	HIGH	29111.30	19.394

ELECTRIC AND HYBRID VEHICLE COST MODEL

5 PAX NIZN2.0 150M ELEC 08-08-1984

--INPUTS--

GENERAL --		YEAR:	1982
VEHICLE SIZE:	5-PASS	REAL INTEREST RATE:	10 %
CURB WEIGHT:	1669 KG	VEHICLE SALVAGE VALUE:	10 %
VEHICLE WEIGHT , WT:	1805		
LIFE:	150106.7 KM	ACCESSORY COST:	$ 200
BATTERY --		NAME:	NI-ZN
BATTERY WEIGHT:	522 KG	BATTERY CYCLE LIFE:	600
ELECTRICITY COST:	.05 $/KW-H	MAXIMUM SHELF LIFE:	10 YEARS
AVERAGE DAILY DEPTH OF DISCHARGE:	.164038		
		DEPTH OF A DEEP DISCHARGE:	.8
MAINTENANCE FACTOR:	.75		
TRANSMISSION TYPE:	fixed ratio		
MOTOR --			
RATED POWER:	45.5 KW	TYPE:	AC
CONTROLLER:	50.5 KW		
DRIVING --		AMOUNT:	15010.67 KM/YEAR
ANNUAL ELEC USE:	3242.685 KW-H		

-- OUTPUTS --

COST ITEMS-

	$	C/KM		
BASIC VEHICLE COST	7138.74	4.756		
MOTOR COST	864.50	0.576		
CONTROLLER COST	2272.50	1.514		
EV TRANSMISSION COST	234.83	0.156		
BATTERY LOW	4996.96	3.329	HIGH 5496.66	3.662
INITIAL COST LOW	15507.53	10.331	HIGH16007.22	10.664
DOWNPAYMENT LOW	3101.51	2.066	HIGH 3201.44	2.133
REPLACEM'T BATTS LOW	4996.96	3.329	HIGH 5496.66	3.662
REPAIRS & MAINTENANCE	2171.43	1.447		
REPLACEMENT TIRES	446.55	0.297		
INSURANCE	3479.00	2.318		
GARAGING,PARK, TOLL	782.50	0.521		
TITLE, REG, LIC, LOW.	975.38	0.650	HIGH 1000.36	0.666
ELECTRICITY	1621.34	1.080		
PRIN & INT LOW	12406.02	8.265	HIGH12805.78	8.531
OPERATING COST LOW	26879.18	17.907	HIGH27303.93	18.190
VEHICLE SALVAGE VALUE LOW	4166.08	2.775	HIGH 4542.17	3.026
BATTERY SALVAGE LOW	320.40	0.213	HIGH 320.40	0.213
TOTAL LIFE CYCLE COST	LOW25494.21	16.984	HIGH25642.80	17.083

ELECTRIC AND HYBRID VEHICLE COST MODEL

150-MI ZN/BR 5-P EV 08-29-1984

--INPUTS--

GENERAL --	YEAR: 1982
VEHICLE SIZE: 5-PASS	REAL INTEREST RATE: 10 %
CURB WEIGHT: 2366 KG	VEHICLE SALVAGE VALUE: 10 %
VEHICLE WEIGHT , WT: 2502	
LIFE: 150106.7 KM	ACCESSORY COST: $ 200
BATTERY --	NAME: ZN-BR2/2.4
BATTERY WEIGHT: 1001 KG	BATTERY CYCLE LIFE: 750
ELECTRICITY COST: .05 $/KW-H	MAXIMUM SHELF LIFE: 10 YEARS
AVERAGE DAILY DEPTH OF DISCHARGE: .1979718	
	DEPTH OF A DEEP DISCHARGE: .8
MAINTENANCE FACTOR: 2	
TRANSMISSION TYPE: fixed ratio	
MOTOR --	
RATED POWER: 63.1 KW	TYPE: AC
CONTROLLER: 70.1 KW	
DRIVING --	AMOUNT: 15010.67 KM/YEAR
ANNUAL ELEC USE: 7463.919 KW-H	

-- OUTPUTS --

COST ITEMS-

	$	C/KM		
BASIC VEHICLE COST	8253.79	5.499		
MOTOR COST	1198.90	0.799		
CONTROLLER COST	3154.50	2.102		
EV TRANSMISSION COST	325.97	0.217		
BATTERY LOW	4135.00	2.755	HIGH 7112.19	4.738
INITIAL COST LOW	17068.15	11.371	HIGH20045.34	13.354
DOWNPAYMENT LOW	3413.63	2.274	HIGH 4009.07	2.671
REPLACEM'T BATTS LOW	4135.00	2.755	HIGH 7112.19	4.738
REPAIRS & MAINTENANCE	4479.33	2.984		
REPLACEMENT TIRES	530.49	0.353		
INSURANCE	3479.00	2.318		
GARAGING,PARK, TOLL	782.50	0.521		
TITLE, REG, LIC, LOW.	1053.41	0.702	HIGH 1202.27	0.801
ELECTRICITY	3731.96	2.486		
PRIN & INT LOW	13654.52	9.097	HIGH16036.28	10.683
OPERATING COST LOW	31846.20	21.216	HIGH34376.81	22.902
VEHICLE SALVAGE VALUE LOW	3788.73	2.524	HIGH 6157.60	4.102
BATTERY SALVAGE LOW	98.10	0.065	HIGH 98.10	0.065
TOTAL LIFE CYCLE COST LOW	31373.00	20.900	HIGH32130.19	21.405

ELECTRIC AND HYBRID VEHICLE COST MODEL

150-MI ZN/CL 5-P EV 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1995 KG
VEHICLE WEIGHT , WT: 2131
LIFE: 150106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 746 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .165561

NAME: ZN-CL2/2.4
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 53.7 KW
CONTROLLER: 59.7 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 5529.819 KW-H

AMOUNT: 15010.67 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	7660.73	5.104			
MOTOR COST	1020.30	0.680			
CONTROLLER COST	2686.50	1.790			
EV TRANSMISSION COST	277.61	0.185			
BATTERY LOW	7931.22	5.284	HIGH	8248.47	5.495
INITIAL COST LOW	19576.36	13.042	HIGH	19893.60	13.253
DOWNPAYMENT LOW	3915.27	2.608	HIGH	3978.72	2.651
REPLACEM'T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	4479.33	2.984			
REPLACEMENT TIRES	485.81	0.324			
INSURANCE	3479.00	2.318			
GARAGING,PARK, TOLL	782.50	0.521			
TITLE, REG, LIC, LOW.	1178.82	0.785	HIGH	1194.68	0.796
ELECTRICITY	2764.91	1.842			
PRIN & INT LOW	15661.09	10.433	HIGH	15914.88	10.602
OPERATING COST LOW	28831.45	19.207	HIGH	29101.11	19.387
VEHICLE SALVAGE VALUE LOW	448.97	0.299	HIGH	448.97	0.299
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	32297.75	21.517	HIGH	32630.85	21.738

ELECTRIC AND HYBRID VEHICLE COST MODEL

5 PAX FEAIR2.4 150M ELEC 01-01-1980

--INPUTS--

GENERAL --		YEAR:	1982
VEHICLE SIZE:	5-PASS	REAL INTEREST RATE:	10 %
CURB WEIGHT:	1933 KG	VEHICLE SALVAGE VALUE:	10 %
VEHICLE WEIGHT , WT:	2069		
LIFE:	150106.7 KM	ACCESSORY COST:	$ 200

BATTERY --		NAME:	FE-AIR2.4
BATTERY WEIGHT:	704 KG	BATTERY CYCLE LIFE:	500
ELECTRICITY COST:	.05 $/KW-H	MAXIMUM SHELF LIFE:	10 YEARS
AVERAGE DAILY DEPTH OF DISCHARGE:	.1629327		
		DEPTH OF A DEEP DISCHARGE:	.8
MAINTENANCE FACTOR:	2		

TRANSMISSION TYPE: fixed ratio

MOTOR --			
RATED POWER:	52.1 KW	TYPE:	AC
CONTROLLER:	57.9 KW		

DRIVING --		AMOUNT:	15010.67 KM/YEAR
ANNUAL ELEC USE:	6675.487 KW-H		

-- OUTPUTS --

COST ITEMS-

		$	C/KM		
BASIC VEHICLE COST		7558.23	5.035		
MOTOR COST		989.90	0.659		
CONTROLLER COST		2605.50	1.736		
EV TRANSMISSION COST		269.24	0.179		
BATTERY	LOW	5244.79	3.494	HIGH 9597.96	6.394
		-------	------		
INITIAL COST	LOW	16667.66	11.104	HIGH21020.83	14.004
DOWNPAYMENT	LOW	3333.53	2.221	HIGH 4204.17	2.801
REPLACEM'T BATTS	LOW	5244.79	3.494	HIGH 9597.96	6.394
REPAIRS & MAINTENANCE		4479.33	2.984		
REPLACEMENT TIRES		478.34	0.319		
INSURANCE		3479.00	2.318		
GARAGING,PARK, TOLL		782.50	0.521		
TITLE, REG, LIC,	LOW.	1033.38	0.688	HIGH 1251.04	0.833
ELECTRICITY		3337.74	2.224		
PRIN & INT	LOW	13334.12	8.883	HIGH16816.66	11.203
		-------	------		
OPERATING COST	LOW	32169.20	21.431	HIGH35869.40	23.896
VEHICLE SALVAGE VALUE	LOW	3132.23	2.087	HIGH 5366,45	3.575
BATTERY SALVAGE	LOW	0.00	0.000	HIGH 0.00	0.000
TOTAL LIFE CYCLE COST	LOW	32370.51	21.565	HIGH34707.11	23.122

ELECTRIC AND HYBRID VEHICLE COST MODEL

150-MI LI/FES 5-P EV 08-29-1984

—INPUTS—

GENERAL —
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1565 KG
VEHICLE WEIGHT , WT: 1701
LIFE: 150106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY —
BATTERY WEIGHT: 451 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .1454846
MAINTENANCE FACTOR: 1.25

NAME: LI-FE-S2.4
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

TRANSMISSION TYPE: fixed ratio
MOTOR —
RATED POWER: 42.9 KW
CONTROLLER: 47.6 KW

TYPE: AC

DRIVING —
ANNUAL ELEC USE: 3690.979 KW-H

AMOUNT: 15010.67 KM/YEAR

— OUTPUTS —

COST ITEMS-

	$	C/KM		$	C/KM
BASIC VEHICLE COST	6968.52	4.642			
MOTOR COST	815.10	0.543			
CONTROLLER COST	2142.00	1.427			
EV TRANSMISSION COST	221.34	0.147			
BATTERY LOW	5094.03	3.394	HIGH	6061.89	4.038
INITIAL COST LOW	15240.99	10.153	HIGH	16208.85	10.798
DOWNPAYMENT LOW	3048.20	2.031	HIGH	3241.77	2.160
REPLACEM'T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	3094.59	2.062			
REPLACEMENT TIRES	434.02	0.289			
INSURANCE	3479.00	2.318			
GARAGING,PARK, TOLL	782.50	0.521			
TITLE, REG, LIC, LOW.	962.05	0.641	HIGH	1010.44	0.673
ELECTRICITY	1845.49	1.229			
PRIN & INT LOW	12192.79	8.123	HIGH	12967.08	8.639
OPERATING COST LOW	22790.44	15.183	HIGH	23613.12	15.731
VEHICLE SALVAGE VALUE LOW	391.21	0.261	HIGH	391.21	0.261
BATTERY SALVAGE LOW	73.06	0.049	HIGH	73.06	0.049
TOTAL LIFE CYCLE COST LOW	25374.36	16.904	HIGH	26390.62	17.581

ELECTRIC AND HYBRID VEHICLE COST MODEL

5-P NA/S2.4 150-MI EV   09-20-1984

--INPUTS--

GENERAL --   YEAR: 1982

VEHICLE SIZE: 5-PASS   REAL INTEREST RATE: 10 %
CURB WEIGHT: 1421 KG   VEHICLE SALVAGE VALUE: 10 %
VEHICLE WEIGHT , WT: 1557
LIFE: 148368.5 KM   ACCESSORY COST: $ 200

BATTERY --   NAME: NA-S2.4

BATTERY WEIGHT: 352 KG   BATTERY CYCLE LIFE: 750
ELECTRICITY COST: .05 $/KW-H   MAXIMUM SHELF LIFE: 10 YEARS
AVERAGE DAILY DEPTH OF DISCHARGE: .165598
DEPTH OF A DEEP DISCHARGE: .8
MAINTENANCE FACTOR: 1.25

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 39.2 KW   TYPE: AC
CONTROLLER: 43.6 KW

DRIVING --   AMOUNT: 14836.85 KM/YEAR
ANNUAL ELEC USE: 3108.453 KW-H

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		6738.95	4.542			
MOTOR COST		744.80	0.502			
CONTROLLER COST		1962.00	1.322			
EV TRANSMISSION COST		202.74	0.137			
BATTERY	LOW	6838.13	4.609	HIGH	7198.04	4.851
		-------	------			
INITIAL COST	LOW	16486.62	11.112	HIGH	16846.52	11.355
DOWNPAYMENT	LOW	3297.32	2.222	HIGH	3369.30	2.271
REPLACEM'T BATTS	LOW	6838.13	4.609	HIGH	7198.04	4.851
REPAIRS & MAINTENANCE		3067.87	2.068			
REPLACEMENT TIRES		408.23	0.275			
INSURANCE		3479.00	2.345			
GARAGING.PARK, TOLL		782.50	0.527			
TITLE, REG, LIC,	LOW.	1024.33	0.690	HIGH	1042.33	0.703
ELECTRICITY		1554.23	1.048			
PRIN & INT	LOW	13189.30	8.890	HIGH	13477.22	9.084
		-------	------			
OPERATING COST	LOW	30343.59	20.452	HIGH	30649.50	20.658
VEHICLE SALVAGE VALUE	LOW	7159.61	4.826	HIGH	7516.85	5.066
BATTERY SALVAGE	LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST	LOW	26481.30	17.848	HIGH	26501.96	17.862

ELECTRIC AND HYBRID VEHICLE COST MODEL

5 PAX BASELINE ICE 250M 07-18-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 895 KG
VEHICLE WEIGHT , WT: 1031
LIFE: 166106 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 0 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: 1
MAINTENANCE FACTOR: 1

NAME: XX
BATTERY CYCLE LIFE: 1
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

ENGINE --
TANK CAPACITY: 40 L
ICE TRANSMISSION TYPE: CVT

FUEL COST: .373 $/L
FUEL TYPE: METHANOL
POWER: 31 KW

MOTOR --
RATED POWER: 0 KW
CONTROLLER: 0 KW
EV TRANSMISSION TYPE: fixed ratio

TYPE: AC

DRIVING --
ICE FRACTIONAL RANGE: 100 %
ANNUAL FUEL USE: 1610 L

AMOUNT: 16610.6 KM/YEAR
EV FRACTIONAL RANGE: 0 %
ANNUAL ELEC USE: 0 KW-H

-- OUTPUTS --

COST ITEMS-

		$	C/KM		$	C/KM
BASIC VEHICLE COST		5745.61	3.459			
ENGINE COST		1118.03	0.673			
ICE TRANSMISSION COST		346.27	0.208			
MOTOR COST		0.00	0.000			
CONTROLLER COST		0.00	0.000			
EV TRANSMISSION COST		0.00	0.000			
BATTERY	LOW	0.00	0.000	HIGH	0.00	0.000
INITIAL COST	LOW	7209.90	4.341	HIGH	7209.90	4.341
DOWNPAYMENT	LOW	1441.98	0.868	HIGH	1441.98	0.868
REPLACEM'T BATTS	LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE		5352.12	3.222			
REPLACEMENT TIRES		419.27	0.252			
INSURANCE		3479.00	2.094			
GARAGING,PARK, TOLL		782.50	0.471			
TITLE, REG, LIC,	LOW.	560.50	0.337	HIGH	560.50	0.337
FUEL-OIL		6185.46	3.724			
ELECTRICITY		0.00	0.000			
PRIN & INT	LOW	5767.92	3.472	HIGH	5767.92	3.472
OPERATING COST	LOW	22546.77	13.574	HIGH	22546.77	13.574
VEHICLE SALVAGE VALUE	LOW	277.97	0.167	HIGH	277.97	0.167
BATTERY SALVAGE	LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST	LOW	23710.78	14.274	HIGH	23710.78	14.274

ELECTRIC AND HYBRID VEHICLE COST MODEL

250-MI ZN/CL 5-P EV 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 2203 KG
VEHICLE WEIGHT , WT: 2339
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 889 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: 9.952912E-02

NAME: ZN-CL2/1.0
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 58.9 KW
CONTROLLER: 65.5 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 6548.096 KW-H

AMOUNT: 16610.67 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	7994.21	4.813			
MOTOR COST	1119.10	0.674			
CONTROLLER COST	2947.50	1.774			
EV TRANSMISSION COST	304.58	0.183			
BATTERY LOW	7338.60	4.418	HIGH	9099.86	5.478
INITIAL COST LOW	19703.99	11.862	HIGH	21465.25	12.923
DOWNPAYMENT LOW	3940.80	2.372	HIGH	4293.05	2.585
REPLACEM'T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	4604.53	2.772			
REPLACEMENT TIRES	606.20	0.365			
INSURANCE	3479.00	2.094			
GARAGING,PARK, TOLL	782.50	0.471			
TITLE, REG, LIC, LOW.	1185.20	0.714	HIGH	1273.26	0.767
ELECTRICITY	3274.05	1.971			
PRIN & INT LOW	15763.19	9.490	HIGH	17172.20	10.338
OPERATING COST LOW	29694.67	17.877	HIGH	31191.74	18.778
VEHICLE SALVAGE VALUE LOW	476.74	0.287	HIGH	476.74	0.287
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	33158.72	19.962	HIGH	35008.05	21.076

ELECTRIC AND HYBRID VEHICLE COST MODEL

5 PAX FEAIR1.0 250M ELEC 01-01-1980

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1963 KG
VEHICLE WEIGHT , WT: 2099
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 724 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .1076278

NAME: FE-AIR1.0
BATTERY CYCLE LIFE: 500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio

MOTOR --
RATED POWER: 52.9 KW
CONTROLLER: 58.8 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 7350.271 KW-H

AMOUNT: 16610.67 KM/YEAR

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		7609.48	4.581			
MOTOR COST		1005.10	0.605			
CONTROLLER COST		2646.00	1.593			
EV TRANSMISSION COST		273.42	0.165			
BATTERY	LOW	4530.45	2.727	HIGH	8290.72	4.991
		-------	------			
INITIAL COST	LOW	16064.45	9.671	HIGH	19824.72	11.935
DOWNPAYMENT	LOW	3212.89	1.934	HIGH	3964.94	2.387
REPLACEM'T BATTS	LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE		4604.53	2.772			
REPLACEMENT TIRES		571.90	0.344			
INSURANCE		3479.00	2.094			
GARAGING,PARK, TOLL		782.50	0.471			
TITLE, REG, LIC,	LOW.	1003.22	0.604	HIGH	1191.24	0.717
ELECTRICITY		3675.14	2.213			
PRIN & INT	LOW	12851.56	7.737	HIGH	15859.78	9.548
		-------	------			
OPERATING COST	LOW	26967.85	16.235	HIGH	30164.08	18.159
VEHICLE SALVAGE VALUE	LOW	444.69	0.268	HIGH	444.69	0.268
BATTERY SALVAGE	LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST	LOW	29736.05	17.902	HIGH	33684.34	20.279

ELECTRIC AND HYBRID VEHICLE COST MODEL

250-MI LI/FES 5-P EV 08-29-1984

—INPUTS—

GENERAL —
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1804 KG
VEHICLE WEIGHT , WT: 1940
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY —
BATTERY WEIGHT: 615 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .1008848

NAME: LI-FE-S1.0
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.25

TRANSMISSION TYPE: fixed ratio

MOTOR —
RATED POWER: 48.9 KW
CONTROLLER: 54.3 KW

TYPE: AC

DRIVING —
ANNUAL ELEC USE: 4480.493 KW-H

AMOUNT: 16610.67 KM/YEAR

— OUTPUTS —

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	7353.25	4.427			
MOTOR COST	929.10	0.559			
CONTROLLER COST	2443.50	1.471			
EV TRANSMISSION COST	252.50	0.152			
BATTERY LOW	8360.80	5.033	HIGH	10701.82	6.443
INITIAL COST LOW	19339.14	11.643	HIGH	21680.16	13.052
DOWNPAYMENT LOW	3867.83	2.329	HIGH	4336.03	2.610
REPLACEM'T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	3184.32	1.917			
REPLACEMENT TIRES	549.18	0.331			
INSURANCE	3479.00	2.094			
GARAGING,PARK, TOLL	782.50	0.471			
TITLE, REG, LIC, LOW.	1166.96	0.703	HIGH	1284.01	0.773
ELECTRICITY	2240.25	1.349			
PRIN & INT LOW	15471.31	9.314	HIGH	17344.13	10.442
OPERATING COST LOW	26873.51	16.178	HIGH	28863.38	17.376
VEHICLE SALVAGE VALUE LOW	423.26	0.255	HIGH	423.26	0.255
BATTERY SALVAGE LOW	125.46	0.076	HIGH	125.46	0.076
TOTAL LIFE CYCLE COST LOW	30192.62	18.177	HIGH	32650.69	19.656

ELECTRIC AND HYBRID VEHICLE COST MODEL

250-MI NA/S 5-P EV 08-13-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1545 KG
VEHICLE WEIGHT , WT: 1681
LIFE: 166106 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 437 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .1086016

NAME: NA-S3.3
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.75

TRANSMISSION TYPE: fixed ratio

MOTOR --
RATED POWER: 42.4 KW
CONTROLLER: 47.1 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 3616 KW-H

AMOUNT: 16610.6 KM/YEAR

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		6937.75	4.177			
MOTOR COST		805.60	0.485			
CONTROLLER COST		2119.50	1.276			
EV TRANSMISSION COST		219.02	0.132			
BATTERY	LOW	8184.77	4.927	HIGH	8994.25	5.415
		-------	------			
INITIAL COST	LOW	18266.63	10.997	HIGH	19076.12	11.484
DOWNPAYMENT	LOW	3653.33	2.199	HIGH	3815.22	2.297
REPLACEM'T BATTS	LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE		4131.12	2.487			
REPLACEMENT TIRES		512.16	0.308			
INSURANCE		3479.00	2.094			
GARAGING,PARK, TOLL		782.50	0.471			
TITLE, REG, LIC,	LOW.	1113.33	0.670	HIGH	1153.81	0.695
ELECTRICITY		1808.00	1.088			
PRIN & INT	LOW	14613.31	8.798	HIGH	15260.89	9.187
		-------	------			
OPERATING COST	LOW	26439.42	15.917	HIGH	27127.47	16.331
VEHICLE SALVAGE VALUE	LOW	388.70	0.234	HIGH	388.70	0.234
BATTERY SALVAGE	LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST	LOW	29704.04	17.883	HIGH	30554.00	18.394

ELECTRIC AND HYBRID VEHICLE COST MODEL

AL/AIR 5-P EV 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1995 KG
VEHICLE WEIGHT , WT: 2131
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 746 KG
ELECTRICITY COST: 0 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .1003373

NAME: AL-AIR
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2.25

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 53.7 KW
CONTROLLER: 59.7 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 24841.87 KW-H

AMOUNT: 16610.67 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	7660.73	4.612			
MOTOR COST	1020.30	0.614			
CONTROLLER COST	2686.50	1.617			
EV TRANSMISSION COST	277.61	0.167			
BATTERY LOW	6707.90	4.038	HIGH	10061.85	6.057
INITIAL COST LOW	18353.03	11.049	HIGH	21706.98	13.068
DOWNPAYMENT LOW	3670.61	2.210	HIGH	4341.40	2.614
REPLACEM'T BATTS LOW	7261.56	4.372	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	5077.94	3.057			
REPLACEMENT TIRES	576.47	0.347			
INSURANCE	3479.00	2.094			
GARAGING,PARK, TOLL	782.50	0.471			
TITLE, REG, LIC, LOW.	1117.65	0.673	HIGH	1285.35	0.774
ELECTRICITY	10381.67	6.250			
PRIN & INT LOW	14682.42	8.839	HIGH	17365.58	10.454
OPERATING COST LOW	43359.22	26.103	HIGH	46210.07	27.820
VEHICLE SALVAGE VALUE LOW	448.97	0.270	HIGH	448.97	0.270
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	46580.85	28.043	HIGH	50102.49	30.163

ELECTRIC AND HYBRID VEHICLE COST MODEL

50-mi PB/ACID HYBRID 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1747 KG
VEHICLE WEIGHT , WT: 1883
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 410 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .3336073

NAME: PBAC/AD3.3
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS

DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1

ENGINE --
TANK CAPACITY: 40 L
ICE TRANSMISSION TYPE: CVT

FUEL COST: .373 $/L
FUEL TYPE: METHANOL
POWER: 52.7 KW

MOTOR --
RATED POWER: 47.5 KW
CONTROLLER: 52.7 KW
EV TRANSMISSION TYPE: fixed ratio

TYPE: AC

DRIVING --
ICE FRACTIONAL RANGE: 22.15058 %
ANNUAL FUEL USE: 486.0288 L

AMOUNT: 16610.67 KM/YEAR
EV FRACTIONAL RANGE: 74.3363 %
ANNUAL ELEC USE: 2635.126 KW-H

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		7267.10	4.375			
ENGINE COST		1331.99	0.802			
ICE TRANSMISSION COST		588.66	0.354			
MOTOR COST		902.50	0.543			
CONTROLLER COST		2371.50	1.428			
EV TRANSMISSION COST		245.06	0.148			
BATTERY	LOW	2164.30	1.303	HIGH	2748.66	1.655
INITIAL COST	LOW	14871.10	8.953	HIGH	15455.46	9.305
DOWNPAYMENT	LOW	2974.22	1.791	HIGH	3091.09	1.861
REPLACEM'T BATTS	LOW	4328.60	2.606	HIGH	5497.33	3.310
REPAIRS & MAINTENANCE		4289.90	2.583			
REPLACEMENT TIRES		541.03	0.326			
INSURANCE		3479.00	2.094			
GARAGING,PARK, TOLL		782.50	0.471			
TITLE, REG, LIC,	LOW.	943.56	0.568	HIGH	972.77	0.586
FUEL-OIL		1867.27	1.124			
ELECTRICITY		1317.56	0.793			
PRIN & INT	LOW	11896.88	7.162	HIGH	12364.37	7.444
OPERATING COST	LOW	29446.31	17.727	HIGH	29943.02	18.026
VEHICLE SALVAGE VALUE	LOW	2590.48	1.560	HIGH	3157.63	1.901
BATTERY SALVAGE	LOW	51.73	0.031	HIGH	51.73	0.031
TOTAL LIFE CYCLE COST	LOW	29778.33	17.927	HIGH	29824.75	17.955

ELECTRIC AND HYBRID VEHICLE COST MODEL

50-mi BIPOLAR HYBRID 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1436 KG
VEHICLE WEIGHT , WT: 1572
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 224 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .4007296
MAINTENANCE FACTOR: .5

NAME: PB-AC/BIPL
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

ENGINE --
TANK CAPACITY: 40 L
ICE TRANSMISSION TYPE: CVT

FUEL COST: .373 $/L
FUEL TYPE: METHANOL
POWER: 44 KW

MOTOR --
RATED POWER: 39.6 KW
CONTROLLER: 44 KW
EV TRANSMISSION TYPE: fixed ratio

TYPE: AC

DRIVING --
ICE FRACTIONAL RANGE: 22.15058 %
ANNUAL FUEL USE: 428.0023 L

AMOUNT: 16610.67 KM/YEAR
EV FRACTIONAL RANGE: 74.48466 %
ANNUAL ELEC USE: 1963.772 KW-H

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		6766.50	4.074			
ENGINE COST		1254.99	0.756			
ICE TRANSMISSION COST		491.48	0.296			
MOTOR COST		752.40	0.453			
CONTROLLER COST		1980.00	1.192			
EV TRANSMISSION COST		204.60	0.123			
BATTERY	LOW	1221.82	0.736	HIGH	1832.73	1.103
INITIAL COST	LOW	12671.79	7.629	HIGH	13282.70	7.996
DOWNPAYMENT	LOW	2534.36	1.526	HIGH	2656.54	1.599
REPLACEM'T BATTS	LOW	2443.64	1.471	HIGH	3665.45	2.207
REPAIRS & MAINTENANCE		3587.49	2.160			
REPLACEMENT TIRES		496.59	0.299			
INSURANCE		3479.00	2.094			
GARAGING,PARK, TOLL		782.50	0.471			
TITLE, REG, LIC,	LOW.	833.59	0.502	HIGH	864.14	0.520
FUEL-OIL		1644.34	0.990			
ELECTRICITY		981.89	0.591			
PRIN & INT	LOW	10137.43	6.103	HIGH	10626.16	6.397
OPERATING COST	LOW	24386.46	14.681	HIGH	24905.73	14.994
VEHICLE SALVAGE VALUE	LOW	1128.39	0.679	HIGH	1471.86	0.886
BATTERY SALVAGE	LOW	37.18	0.022	HIGH	37.18	0.022
TOTAL LIFE CYCLE COST	LOW	25755.25	15.505	HIGH	26053.23	15.685

ELECTRIC AND HYBRID VEHICLE COST MODEL

50-mi NI/FE HYBRID 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1618 KG
VEHICLE WEIGHT , WI: 1754
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 333 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .3079728

NAME: NI-FE3.3
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.25

ENGINE --
TANK CAPACITY: 40 L
ICE TRANSMISSION TYPE: CVT

FUEL COST: .373 $/L
FUEL TYPE: METHANOL
POWER: 49.1 KW

MOTOR --
RATED POWER: 44.2 KW
CONTROLLER: 49.1 KW
EV TRANSMISSION TYPE: fixed ratio

TYPE: AC

DRIVING --
ICE FRACTIONAL RANGE: 22.15058 %
ANNUAL FUEL USE: 465.1383 L

AMOUNT: 16610.67 KM/YEAR
EV FRACTIONAL RANGE: 76.64931 %
ANNUAL ELEC USE: 3535.038 KW-H

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		7058.47	4.249			
ENGINE COST		1301.25	0.783			
ICE TRANSMISSION COST		548.45	0.330			
MOTOR COST		839.80	0.506			
CONTROLLER COST		2209.50	1.330			
EV TRANSMISSION COST		228.32	0.137			
BATTERY	LOW	4142.40	2.494	HIGH	4183.82	2.519
INITIAL COST	LOW	16328.18	9.830	HIGH	16369.61	9.855
DOWNPAYMENT	LOW	3265.64	1.966	HIGH	3273.92	1.971
REPLACEM'T BATTS	LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE		4696.56	2.827			
REPLACEMENT TIRES		522.60	0.315			
INSURANCE		3479.00	2.094			
GARAGING, PARK, TOLL		782.50	0.471			
TITLE, REG, LIC,	LOW.	1016.41	0.612	HIGH	1018.48	0.613
FUEL-OIL		1787.01	1.076			
ELECTRICITY		1767.52	1.064			
PRIN & INT	LOW	13062.55	7.864	HIGH	13095.69	7.884
OPERATING COST	LOW	27114.15	16.323	HIGH	27149.36	16.345
VEHICLE SALVAGE VALUE	LOW	469.81	0.283	HIGH	469.81	0.283
BATTERY SALVAGE	LOW	104.86	0.063	HIGH	104.86	0.063
TOTAL LIFE CYCLE COST	LOW	29805.12	17.943	HIGH	29848.61	17.970

ELECTRIC AND HYBRID VEHICLE COST MODEL

50-mi NI/ZN HYBRID 08-29-1984

—INPUTS—

GENERAL —
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1445 KG
VEHICLE WEIGHT , WT: 1581
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY —
BATTERY WEIGHT: 229 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .317455
MAINTENANCE FACTOR: .75

NAME: NI-ZN2.0
BATTERY CYCLE LIFE: 600
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

ENGINE —
TANK CAPACITY: 40 L
ICE TRANSMISSION TYPE: CVT

FUEL COST: .373 $/L
FUEL TYPE: METHANOL
POWER: 44.3 KW

MOTOR —
RATED POWER: 39.8 KW
CONTROLLER: 44.3 KW
EV TRANSMISSION TYPE: fixed ratio

TYPE: AC

DRIVING —
ICE FRACTIONAL RANGE: 22.15058 %
ANNUAL FUEL USE: 430.3245 L

AMOUNT: 16610.67 KM/YEAR
EV FRACTIONAL RANGE: 76.33861 %
ANNUAL ELEC USE: 2541.473 KW-H

— OUTPUTS —

COST ITEMS-

		$	C/KM		
BASIC VEHICLE COST		6782.63	4.083		
ENGINE COST		1257.81	0.757		
ICE TRANSMISSION COST		494.83	0.298		
MOTOR COST		756.20	0.455		
CONTROLLER COST		1993.50	1.200		
EV TRANSMISSION COST		206.00	0.124		
BATTERY	LOW	2192.15	1.320	HIGH 2411.37	1.452
INITIAL COST	LOW	13683.12	8.238	HIGH13902.34	8.370
DOWNPAYMENT	LOW	2736.62	1.648	HIGH 2780.47	1.674
REPLACEM'T BATTS	LOW	4384.31	2.639	HIGH 4822.74	2.903
REPAIRS & MAINTENANCE		3966.43	2.388		
REPLACEMENT TIRES		497.87	0.300		
INSURANCE		3479.00	2.094		
GARAGING,PARK, TOLL		782.50	0.471		
TITLE, REG, LIC,	LOW.	884.16	0.532	HIGH 895.12	0.539
FUEL-OIL		1653.26	0.995		
ELECTRICITY		1270.74	0.765		
PRIN & INT	LOW	10946.50	6.590	HIGH11121.87	6.696
OPERATING COST	LOW	27864.76	16.775	HIGH28051.10	16.887
VEHICLE SALVAGE VALUE	LOW	1727.67	1.040	HIGH 1856.14	1.117
BATTERY SALVAGE	LOW	281.12	0.169	HIGH 281.12	0.169
TOTAL LIFE CYCLE COST	LOW	28592.60	17.213	HIGH28694.31	17.275

ELECTRIC AND HYBRID VEHICLE COST MODEL

50-mi ZN/BR HYBRID 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1783 KG
VEHICLE WEIGHT , WT: 1919
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 432 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .3634617

NAME: ZN-BR2/3.3
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

ENGINE --
TANK CAPACITY: 40 L
ICE TRANSMISSION TYPE: CVT

FUEL COST: .373 $/L
FUEL TYPE: METHANOL
POWER: 53.7 KW

MOTOR --
RATED POWER: 48.4 KW
CONTROLLER: 53.7 KW
EV TRANSMISSION TYPE: fixed ratio

TYPE: AC

DRIVING --
ICE FRACTIONAL RANGE: 22.15058 %
ANNUAL FUEL USE: 512.1392 L

AMOUNT: 16610.67 KM/YEAR
EV FRACTIONAL RANGE: 74.47441 %
ANNUAL ELEC USE: 4647.743 KW-H

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	7322.19	4.408			
ENGINE COST	1340.28	0.807			
ICE TRANSMISSION COST	599.83	0.361			
MOTOR COST	919.60	0.554			
CONTROLLER COST	2416.50	1.455			
EV TRANSMISSION COST	249.71	0.150			
BATTERY LOW	2309.45	1.390	HIGH	4226.30	2.544
INITIAL COST LOW	15157.56	9.125	HIGH	17074.40	10.279
DOWNPAYMENT LOW	3031.51	1.825	HIGH	3414.88	2.056
REPLACEM'T BATTS LOW	4618.91	2.781	HIGH	8452.60	5.089
REPAIRS & MAINTENANCE	5702.78	3.433			
REPLACEMENT TIRES	546.18	0.329			
INSURANCE	3479.00	2.094			
GARAGING,PARK, TOLL	782.50	0.471			
TITLE, REG, LIC, LOW.	957.88	0.577	HIGH	1053.72	0.634
FUEL-OIL	1967.59	1.185			
ELECTRICITY	2323.87	1.399			
PRIN & INT LOW	12126.05	7.300	HIGH	13659.52	8.223
OPERATING COST LOW	32504.75	19.569	HIGH	34134.06	20.549
VEHICLE SALVAGE VALUE LOW	2317.37	1.395	HIGH	3829.65	2.306
BATTERY SALVAGE LOW	69.12	0.042	HIGH	69.12	0.042
TOTAL LIFE CYCLE COST LOW	33149.76	19.957	HIGH	33650.17	20.258

ELECTRIC AND HYBRID VEHICLE COST MODEL

50-mi ZN/CL HYBRID 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1685 KG
VEHICLE WEIGHT , WT: 1821
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 373 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .3337256

NAME: ZN-CL2/3.3
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS

DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

ENGINE --
TANK CAPACITY: 40 L
ICE TRANSMISSION TYPE: CVT

FUEL COST: .373 $/L
FUEL TYPE: METHANOL
POWER: 51 KW

MOTOR --
RATED POWER: 45.9 KW
CONTROLLER: 51 KW
EV TRANSMISSION TYPE: fixed ratio

TYPE: AC

DRIVING --
ICE FRACTIONAL RANGE: 22.15058 %
ANNUAL FUEL USE: 477.8499 L

AMOUNT: 16610.67 KM/YEAR
EV FRACTIONAL RANGE: 75.73663 %
ANNUAL ELEC USE: 4142.915 KW-H

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		7166.08	4.314			
ENGINE COST		1317.65	0.793			
ICE TRANSMISSION COST		569.67	0.343			
MOTOR COST		872.10	0.525			
CONTROLLER COST		2295.00	1.382			
EV TRANSMISSION COST		237.15	0.143			
BATTERY	LOW	4757.33	2.864	HIGH	4804.91	2.893
INITIAL COST	LOW	17214.99	10.364	HIGH	17262.56	10.392
DOWNPAYMENT	LOW	3443.00	2.073	HIGH	3452.51	2.078
REPLACEM'T BATTS	LOW	4757.33	2.864	HIGH	4804.91	2.893
REPAIRS & MAINTENANCE		5750.58	3.462			
REPLACEMENT TIRES		532.17	0.320			
INSURANCE		3479.00	2.094			
GARAGING, PARK, TOLL		782.50	0.471			
TITLE, REG, LIC,	LOW.	1060.75	0.639	HIGH	1063.13	0.640
FUEL-OIL		1835.85	1.105			
ELECTRICITY		2071.46	1.247			
PRIN & INT	LOW	13771.99	8.291	HIGH	13810.05	8.314
OPERATING COST	LOW	34041.63	20.494	HIGH	34082.07	20.518
VEHICLE SALVAGE VALUE	LOW	5165.88	3.110	HIGH	5212.73	3.138
BATTERY SALVAGE	LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST	LOW	32318.75	19.457	HIGH	32321.85	19.458

ELECTRIC AND HYBRID VEHICLE COST MODEL

FE/AIR HYBRID 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1537 KG
VEHICLE WEIGHT , WT: 1673
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 284 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .3614187
MAINTENANCE FACTOR: 2

NAME: FE-AIR3.3
BATTERY CYCLE LIFE: 500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

ENGINE --
TANK CAPACITY: 40 L
ICE TRANSMISSION TYPE: CVT

FUEL COST: .373 $/L
FUEL TYPE: METHANOL
POWER: 46.8 KW

MOTOR --
RATED POWER: 42.2 KW
CONTROLLER: 46.8 KW
EV TRANSMISSION TYPE: fixed ratio

TYPE: AC

DRIVING --
ICE FRACTIONAL RANGE: 22.15058 %
ANNUAL FUEL USE: 470.4655 L

AMOUNT: 16610.67 KM/YEAR
EV FRACTIONAL RANGE: 76.1811 %
ANNUAL ELEC USE: 4481.735 KW-H

-- OUTPUTS --

COST ITEMS-

		$	C/KM		$	C/KM
BASIC VEHICLE COST		6932.15	4.173			
ENGINE COST		1280.81	0.771			
ICE TRANSMISSION COST		522.76	0.315			
MOTOR COST		801.80	0.483			
CONTROLLER COST		2106.00	1.268			
EV TRANSMISSION COST		217.62	0.131			
BATTERY	LOW	2713.15	1.633	HIGH	5507.70	3.316
INITIAL COST	LOW	14574.28	8.774	HIGH	17368.83	10.456
DOWNPAYMENT	LOW	2914.86	1.755	HIGH	3473.77	2.091
REPLACEM'T BATTS	LOW	8139.45	4.900	HIGH	16523.09	9.947
REPAIRS & MAINTENANCE		5767.41	3.472			
REPLACEMENT TIRES		511.02	0.308			
INSURANCE		3479.00	2.094			
GARAGING,PARK, TOLL		782.50	0.471			
TITLE, REG, LIC,	LOW.	928.71	0.559	HIGH	1068.44	0.643
FUEL-OIL		1807.48	1.088			
ELECTRICITY		2240.87	1.349			
PRIN & INT	LOW	11659.42	7.019	HIGH	13895.06	8.365
OPERATING COST	LOW	35315.87	21.261	HIGH	37691.24	22.691
VEHICLE SALVAGE VALUE	LOW	2362.08	1.422	HIGH	4324.00	2.603
BATTERY SALVAGE	LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST	LOW	35868.65	21.594	HIGH	36841.00	22.179

ELECTRIC AND HYBRID VEHICLE COST MODEL

50-mi LI/FES HYBRID 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1517 KG
VEHICLE WEIGHT , WT: 1653
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 273 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2501142

NAME: LI-FE-S3.3
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.25

ENGINE --
TANK CAPACITY: 40 L
ICE TRANSMISSION TYPE: CVT

FUEL COST: .373 $/L
FUEL TYPE: METHANOL
POWER: 46.3 KW

MOTOR --
RATED POWER: 41.7 KW
CONTROLLER: 46.3 KW
EV TRANSMISSION TYPE: fixed ratio

TYPE: AC

DRIVING --
ICE FRACTIONAL RANGE: 22.15058 %
ANNUAL FUEL USE: 444.8058 L

AMOUNT: 16610.67 KM/YEAR
EV FRACTIONAL RANGE: 76.7572 %
ANNUAL ELEC USE: 3160.689 KW-H

-- OUTPUTS --

COST ITEMS-

	$	C/KM		
BASIC VEHICLE COST	6891.41	4.149		
ENGINE COST	1276.27	0.768		
ICE TRANSMISSION COST	517.17	0.311		
MOTOR COST	792.30	0.477		
CONTROLLER COST	2083.50	1.254		
EV TRANSMISSION COST	215.30	0.130		
BATTERY LOW	3709.29	2.233	HIGH 3784.99	2.279
INITIAL COST LOW	15485.24	9.322	HIGH15560.94	9.368
DOWNPAYMENT LOW	3097.05	1.864	HIGH 3112.19	1.874
REPLACEM'T BATTS LOW	3709.29	2.233	HIGH 3784.99	2.279
REPAIRS & MAINTENANCE	4699.12	2.829		
REPLACEMENT TIRES	508.16	0.306		
INSURANCE	3479.00	2.094		
GARAGING,PARK, TOLL	782.50	0.471		
TITLE, REG, LIC, LOW.	974.26	0.587	HIGH 978.05	0.589
FUEL-OIL	1708.90	1.029		
ELECTRICITY	1580.34	0.951		
PRIN & INT LOW	12388.19	7.458	HIGH12448.75	7.494
OPERATING COST LOW	29829.77	17.958	HIGH29894.11	17.997
VEHICLE SALVAGE VALUE LOW	2228.81	1.342	HIGH 2265.03	1.364
BATTERY SALVAGE LOW	38.77	0.023	HIGH 38.77	0.023
TOTAL LIFE CYCLE COST LOW	30659.24	18.458	HIGH30702.51	18.484

ELECTRIC AND HYBRID VEHICLE COST MODEL

50-mi NA/S HYBRID 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1340 KG
VEHICLE WEIGHT , WT: 1476
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 167 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .3474551

NAME: NA-S3.3
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.75

ENGINE --
TANK CAPACITY: 40 L
ICE TRANSMISSION TYPE: CVT

FUEL COST: .373 $/L
FUEL TYPE: METHANOL
POWER: 41.3 KW

MOTOR --
RATED POWER: 37.2 KW
CONTROLLER: 41.3 KW
EV TRANSMISSION TYPE: fixed ratio

TYPE: AC

DRIVING --
ICE FRACTIONAL RANGE: 22.15058 %
ANNUAL FUEL USE: 408.9519 L

AMOUNT: 16610.67 KM/YEAR
EV FRACTIONAL RANGE: 75.1778 %
ANNUAL ELEC USE: 2540.247 KW-H

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	6608.97	3.979			
ENGINE COST	1229.04	0.740			
ICE TRANSMISSION COST	461.32	0.278			
MOTOR COST	706.80	0.426			
CONTROLLER COST	1858.50	1.119			
EV TRANSMISSION COST	192.05	0.116			
BATTERY LOW	3894.51	2.345	HIGH	4279.68	2.576
INITIAL COST LOW	14951.19	9.001	HIGH	15336.36	9.233
DOWNPAYMENT LOW	2990.24	1.800	HIGH	3067.27	1.847
REPLACEM'T BATTS LOW	7789.02	4.689	HIGH	8559.37	5.153
REPAIRS & MAINTENANCE	5373.52	3.235			
REPLACEMENT TIRES	482.87	0.291			
INSURANCE	3479.00	2.094			
GARAGING,PARK, TOLL	782.50	0.471			
TITLE, REG, LIC, LOW.	947.56	0.570	HIGH	966.82	0.582
FUEL-OIL	1571.15	0.946			
ELECTRICITY	1270.12	0.765			
PRIN & INT LOW	11960.95	7.201	HIGH	12269.09	7.386
OPERATING COST LOW	33656.70	20.262	HIGH	33984.09	20.459
VEHICLE SALVAGE VALUE LOW	3878.05	2.335	HIGH	4219.43	2.540
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	32768.89	19.728	HIGH	32831.93	19.766

SPE Fuel Cell Vehicle - Cost Sheet

--INPUTS--

GENERAL --	YEAR: 1982
VEHICLE SIZE: 5-PASS	REAL INTEREST RATE: 10%
CURB WEIGHT: 1205 KG	VEHICLE SALVAGE VALUE: 10%
VEHICLE WEIGHT, WT: 1341 KG	
LIFE: 166100 KM	ACCESSORY COST: $200
FUEL CELL -	NAME: SPE
WEIGHT: 216 KG	
MAINTENANCE FACTOR: 1	
TRANSMISSION TYPE: FIXED RATIO	POWER: 40 KW
MOTOR TYPE: AC	POWER: 40 KW
CONTROLLER TYPE: INVERTER	POWER: 40 KW
DRIVING -	AMOUNT: 16610 KM
ANNUAL FUEL USE: 1353 L	

--OUTPUTS--

COST ITEMS-

	$	C/KM
BASIC VEHICLE COST	7542	4.54
FUEL CELL COST	7344	4.42
MOTOR COST	684	0.41
CONTROLLER COST	1800	1.08
TRANSMISSION COST	184	0.11
INITIAL COST	17554	10.57
DOWNPAYMENT	3511	2.11
REPAIRS & MAINT	4600	2.77
REPL. TIRES	419	0.25
INSURANCE	3479	2.71
GAR.,PARK,TOLL	783	0.61
TITLE,REG.,LIC.	1075	0.65
FUEL	5182	3.12
PRINCIPAL & INT.	14043	8.45
OPERATING COST	29581	17.81
VEH. SALV. (W/O FC)	386	0.23
FC SALV. (16%)	1207	0.73
TOTAL LIFE CYCLE COST	31499	18.96

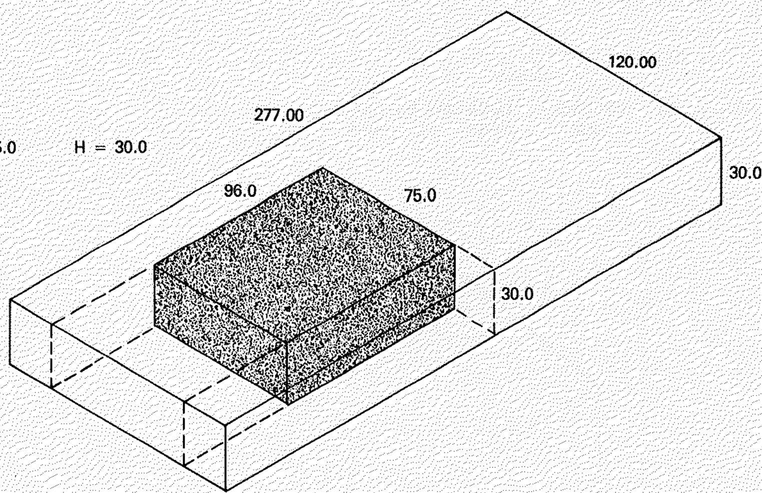
APPENDIX C

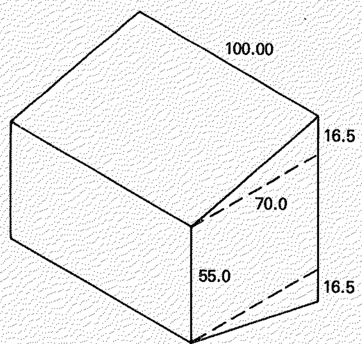
VEHICLE PACKAGING

96-km Pb-Acid Van

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm
453	216	REAR : L = 96.0 W = 75.0 H = 30.0

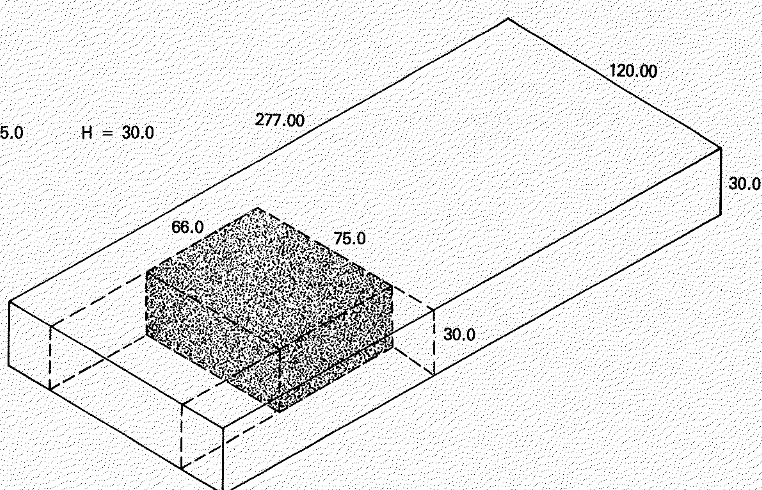


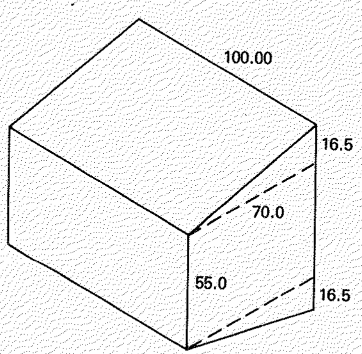


96-km Pb-Acid Bipolar Van

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm
293	148	REAR : L = 66.0 W = 75.0 H = 30.0

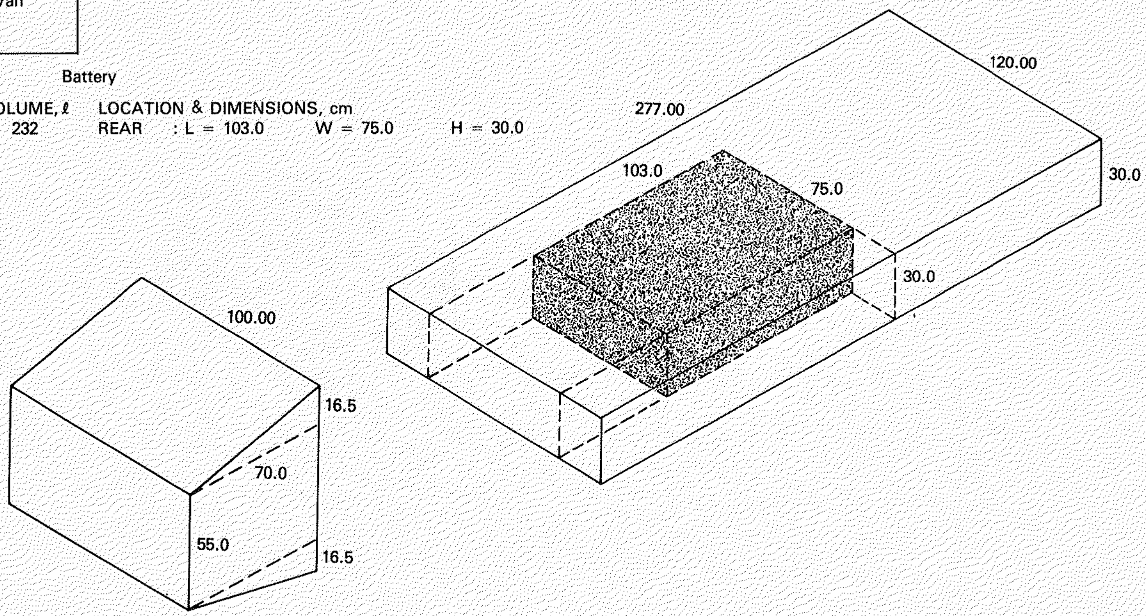




96-km Ni-Fe Van

Battery

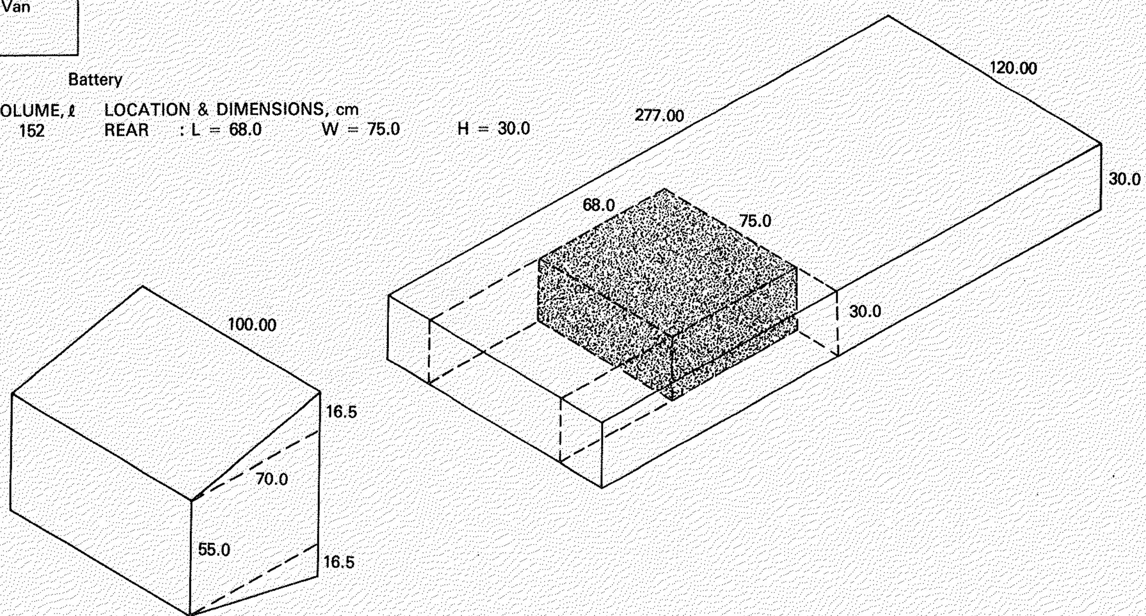
WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
388	232	REAR	: L = 103.0	W = 75.0	H = 30.0



96-km Ni-Zn Van

Battery

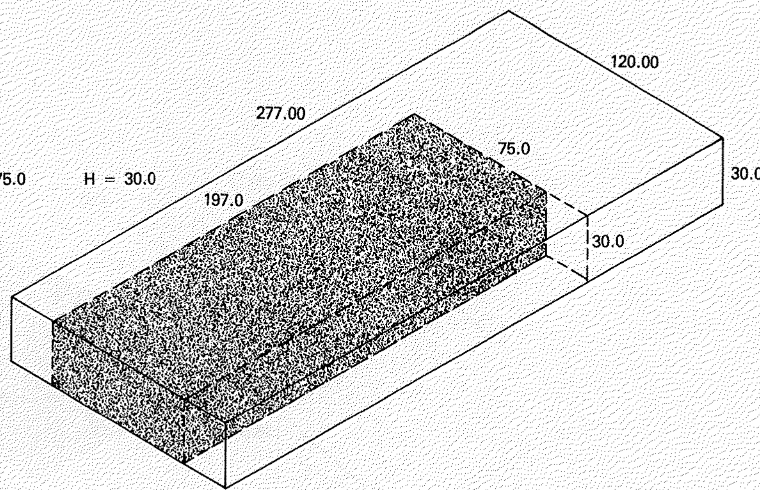
WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
254	152	REAR	: L = 68.0	W = 75.0	H = 30.0

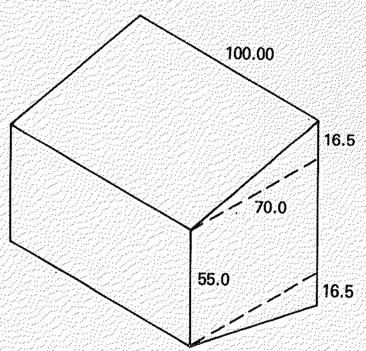


96-km Zn-Br_2 Van

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
444	444	REAR	: L = 197.0	W = 75.0	H = 30.0

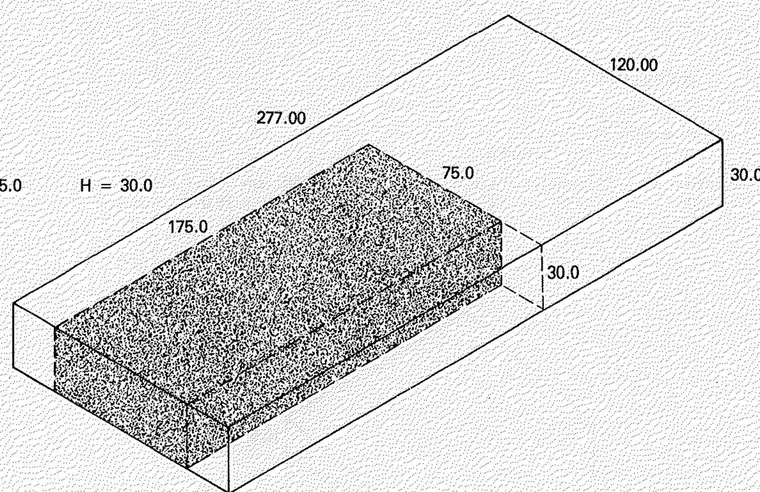


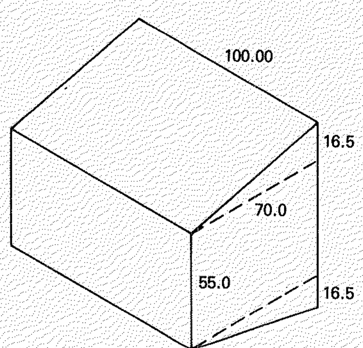


96-km Zn-Cl_2 Van

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
351	394	REAR	: L = 175.0	W = 75.0	H = 30.0

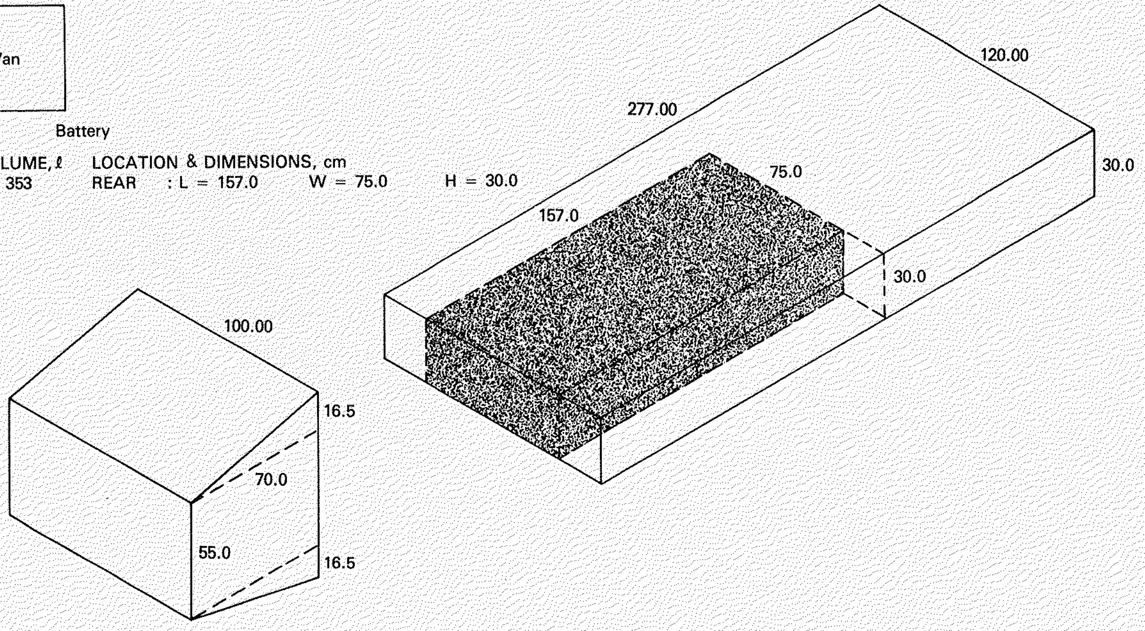




96-km Fe-Air Van

Battery

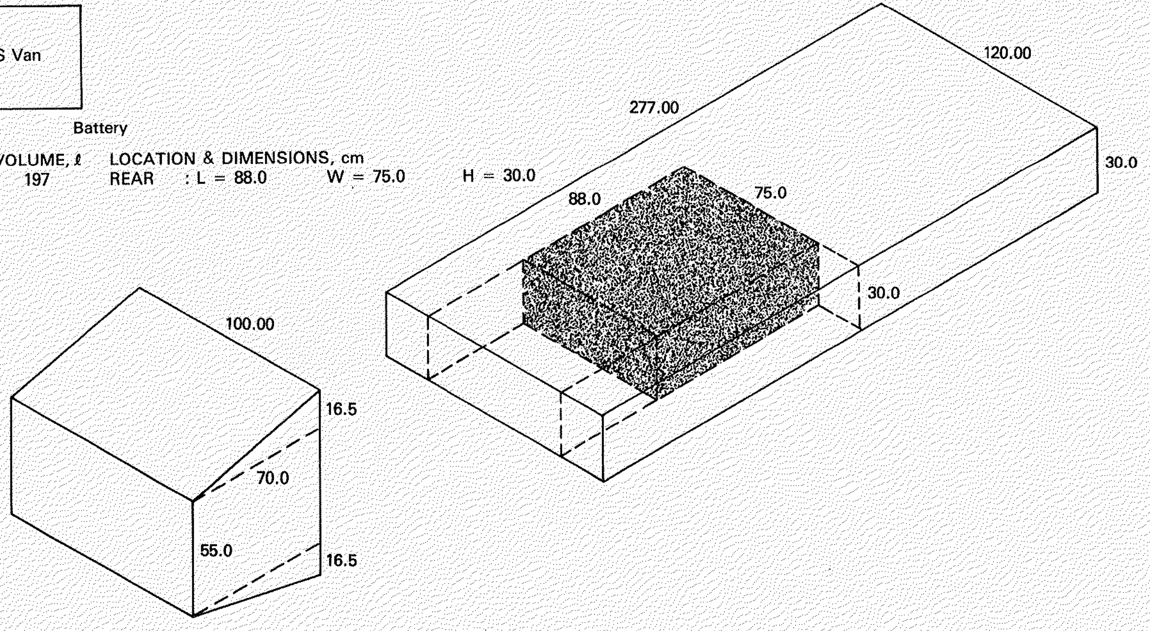
WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
280	353	REAR	: L = 157.0	W = 75.0	H = 30.0



96-km Li-FeS Van

Battery

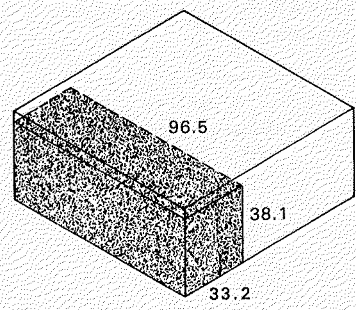
WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
276	197	REAR	: L = 88.0	W = 75.0	H = 30.0

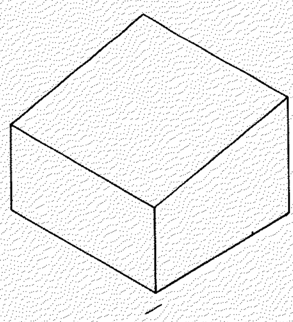


128-km Li-FeS EV
2 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
171	122	REAR	: L = 33.2	W = 96.5	H = 38.1

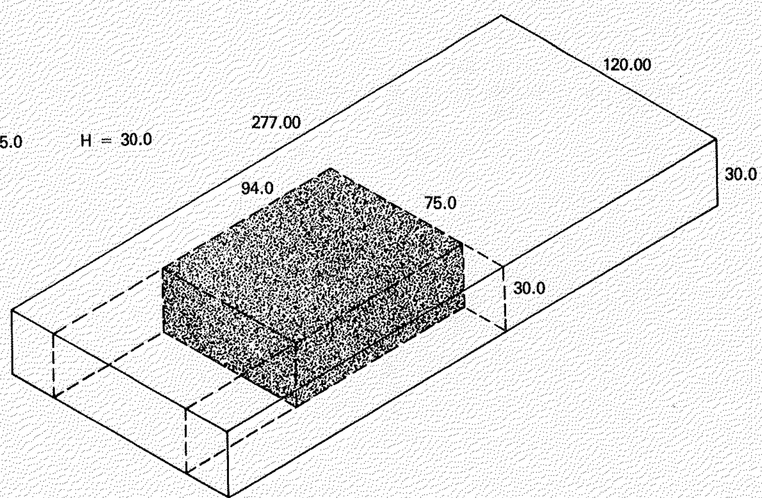


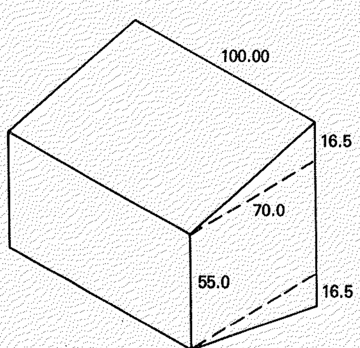


96-km Na-S Van

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
191	211	REAR	: L = 94.0	W = 75.0	H = 30.0

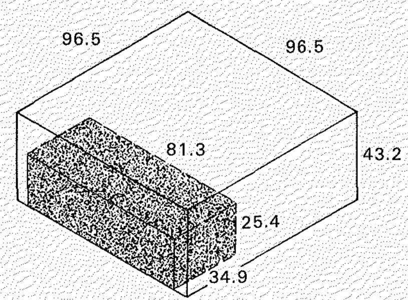


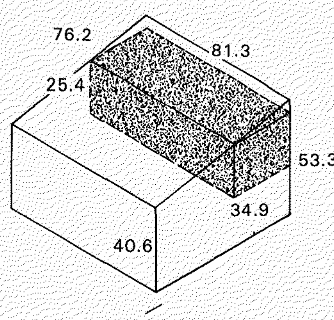


128-km Ni-Fe EV
2 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
246	144	FRONT			
		TUNNEL	: L = 34.9	W = 81.3	H = 25.4
		REAR	: L = 34.9	W = 81.3	H = 25.4

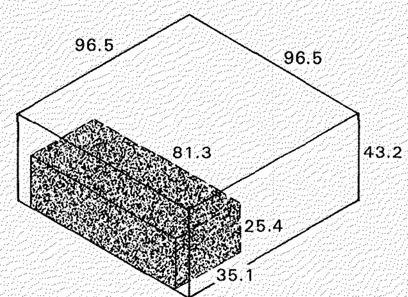


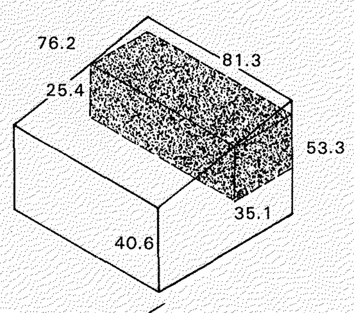


128-km Pb-Acid EV
2 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
306	145	FRONT			
		TUNNEL	: L = 35.1	W = 81.3	H = 25.4
		REAR	: L = 35.1	W = 81.3	H = 25.4

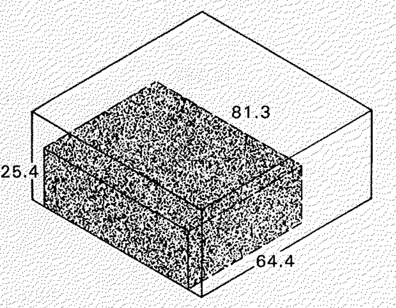


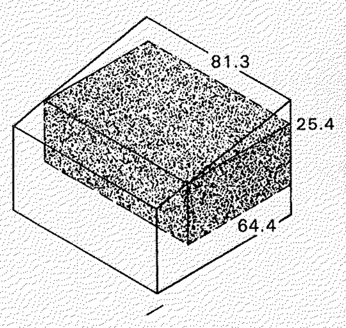


128-km Zn-Cl_2 EV
2 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
267	225	FRONT			
		TUNNEL	: L = 64.4	W = 81.3	H = 25.4
		REAR	: L = 64.4	W = 81.3	H = 25.4

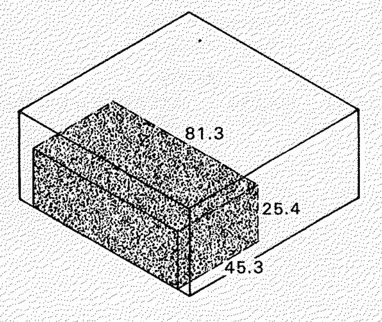


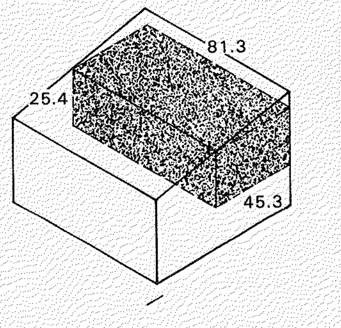


128-km Fe-Air EV
2 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
203	187	FRONT			
		TUNNEL	: L = 45.3	W = 81.3	H = 25.4
		REAR	: L = 45.3	W = 81.3	H = 25.4

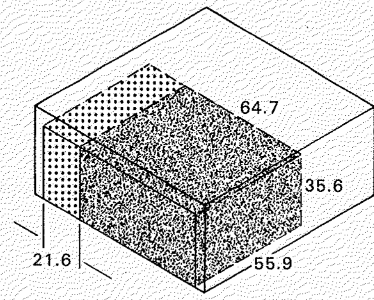


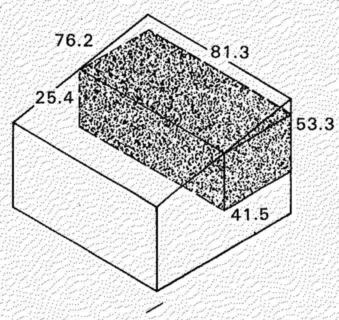


128-km Zn-Br_2 EV
2 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm				
332	257	FRONT				
		TUNNEL	: TANK	L = 41.5	W = 81.3	H = 25.4
		REAR	: TANK	L = 55.9	W = 21.6	H = 35.6
			: BATTERY	L = 55.9	W = 64.7	H = 35.6

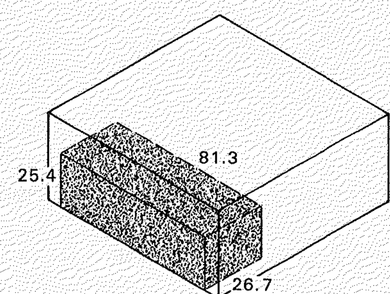


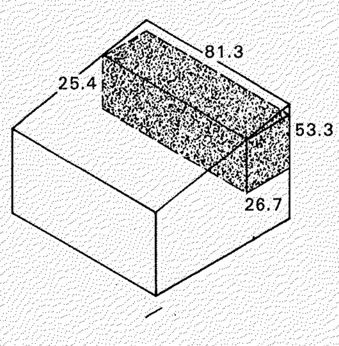


128-km Pb-Acid EV
Bipolar
2 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
217	110	FRONT			
		TUNNEL	: L = 26.7	W = 81.3	H = 25.4
		REAR	: L = 26.7	W = 81.3	H = 25.4

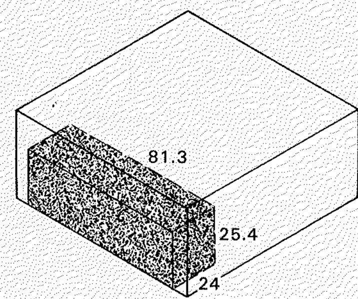


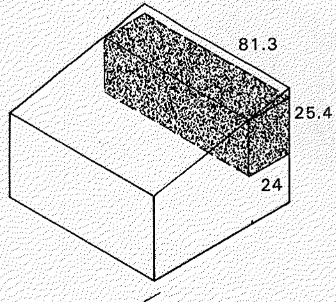


128-km Ni-Zn EV
2 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
165	99	FRONT			
		TUNNEL	: L = 24	W = 81.3	H = 25.4
		REAR	: L = 24	W = 81.3	H = 25.4

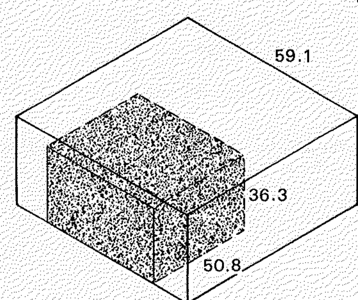


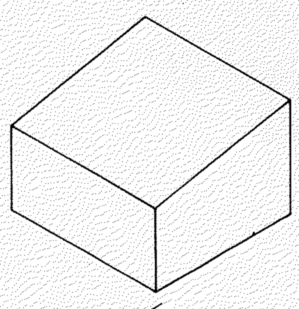


128-km Na-S EV
2 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
118	109	REAR	: L = 50.8	W = 59.1	H = 36.3

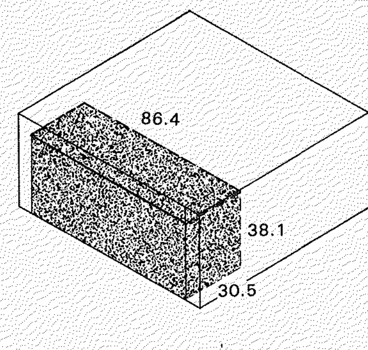


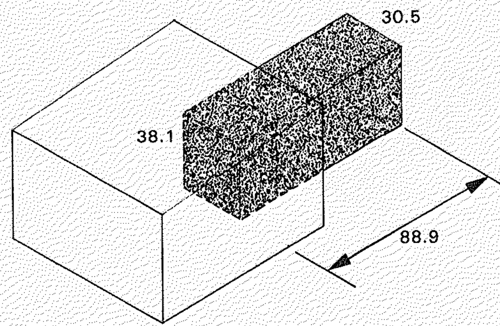


160-km Pb-Acid
Bipolar EV
5 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
404	204	FRONT			
		TUNNEL	: L = 88.9	W = 30.5	H = 38.1
		REAR	: L = 30.5	W = 86.4	H = 38.1

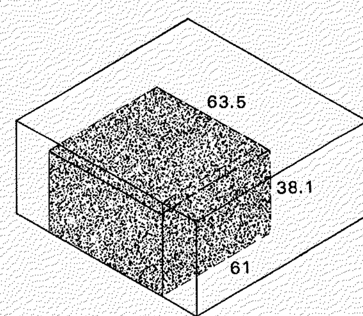


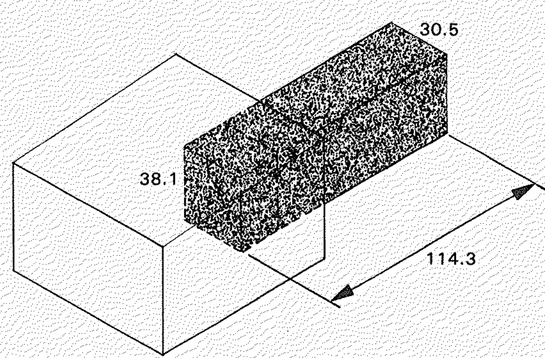


160-km Pb-Acid EV
5 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
590	281	FRONT			
		TUNNEL	: L = 114.3	W = 30.5	H = 38.1
		REAR	: L = 61	W = 63.5	H = 38.1

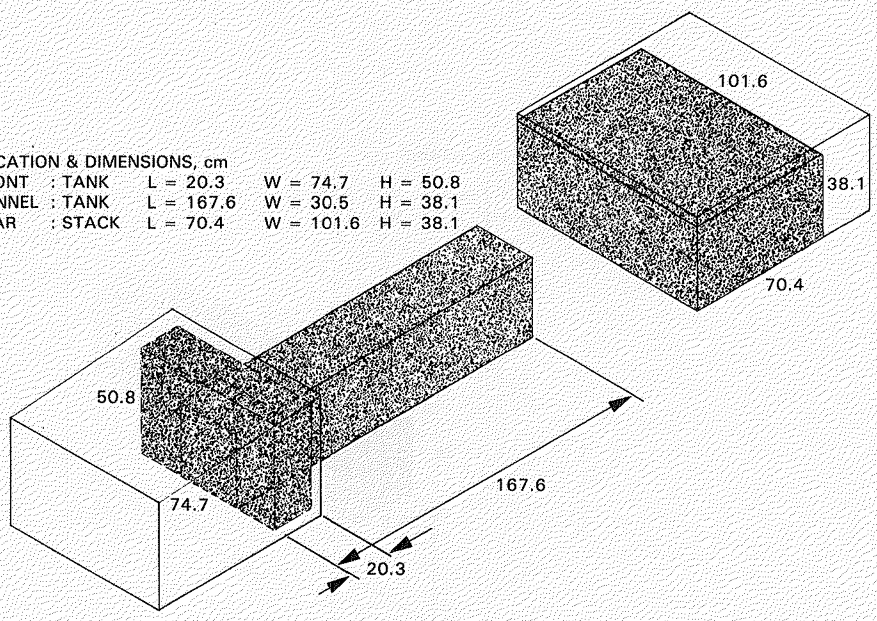




160-km Zn-Br_2 EV
5 - Passenger

Battery

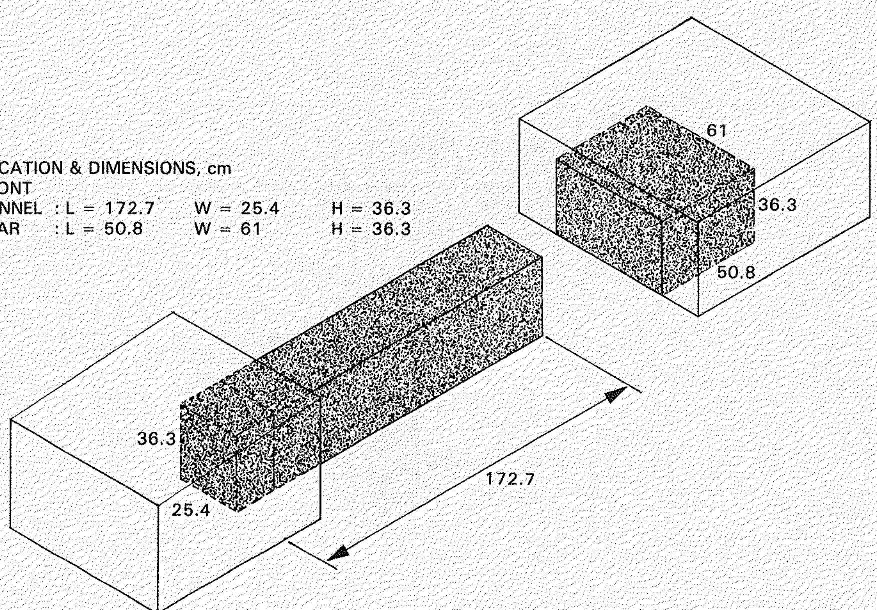
WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm				
544	544	FRONT	: TANK	L = 20.3	W = 74.7	H = 50.8
		TUNNEL	: TANK	L = 167.6	W = 30.5	H = 38.1
		REAR	: STACK	L = 70.4	W = 101.6	H = 38.1



160-km Na-S EV
5 - Passenger

Battery

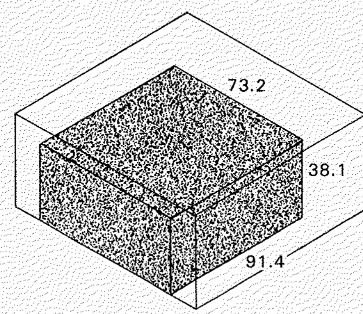
WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
245	271	FRONT			
		TUNNEL	: L = 172.7	W = 25.4	H = 36.3
		REAR	: L = 50.8	W = 61	H = 36.3

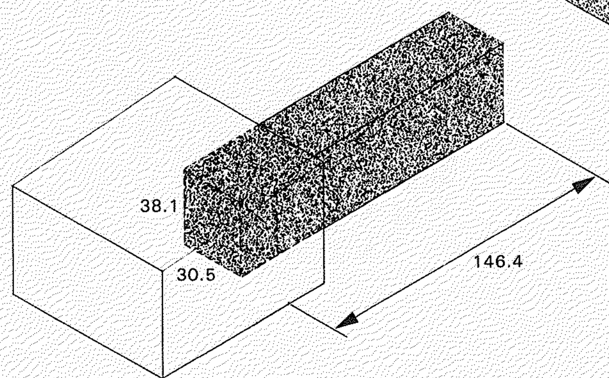


160-km Fe-Air EV
5 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
338	425	FRONT			
		TUNNEL	: L = 146.4	W = 30.5	H = 38.1
		REAR	: L = 91.4	W = 73.2	H = 38.1

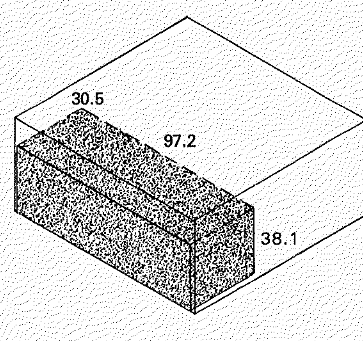


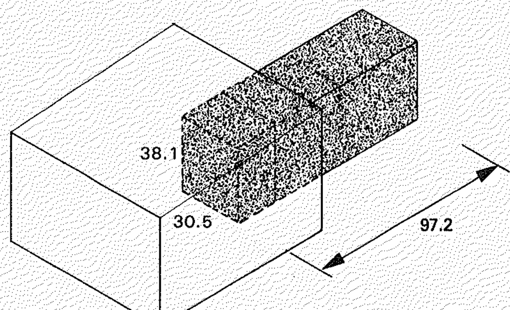


160-km Li-FeS EV
5 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
316	266	FRONT			
		TUNNEL	: L = 97.2	W = 30.5	H = 38.1
		REAR	: L = 30.5	W = 97.2	H = 38.1

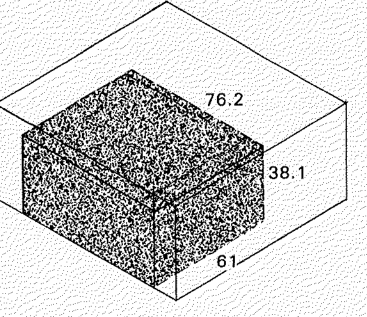


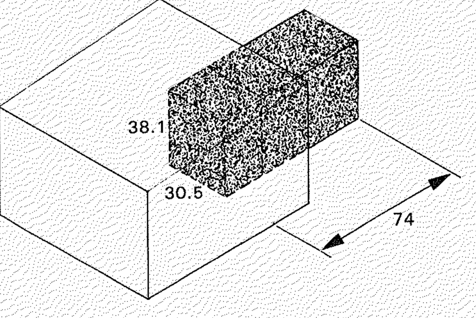


160-km Ni-Fe EV
5 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
437	261	FRONT			
		TUNNEL	: L = 74	W = 30.5	H = 38.1
		REAR	: L = 61	W = 76.2	H = 38.1

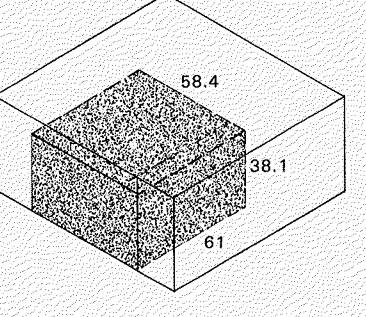


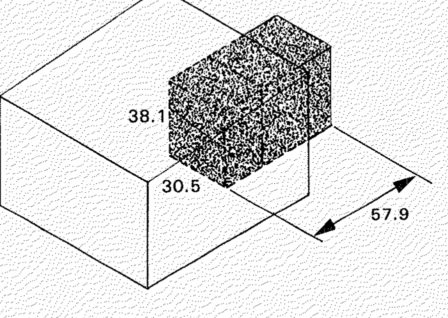


160-km Ni-Zn EV
5 - Passenger

Battery

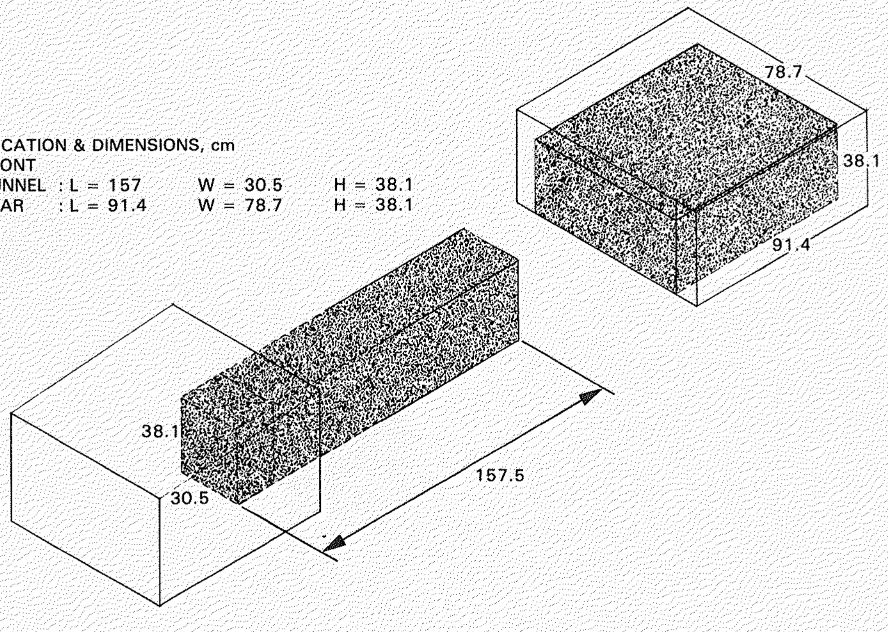
WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
336	202	FRONT			
		TUNNEL	: L = 57.9	W = 30.5	H = 38.1
		REAR	: L = 61	W = 58.4	H = 38.1





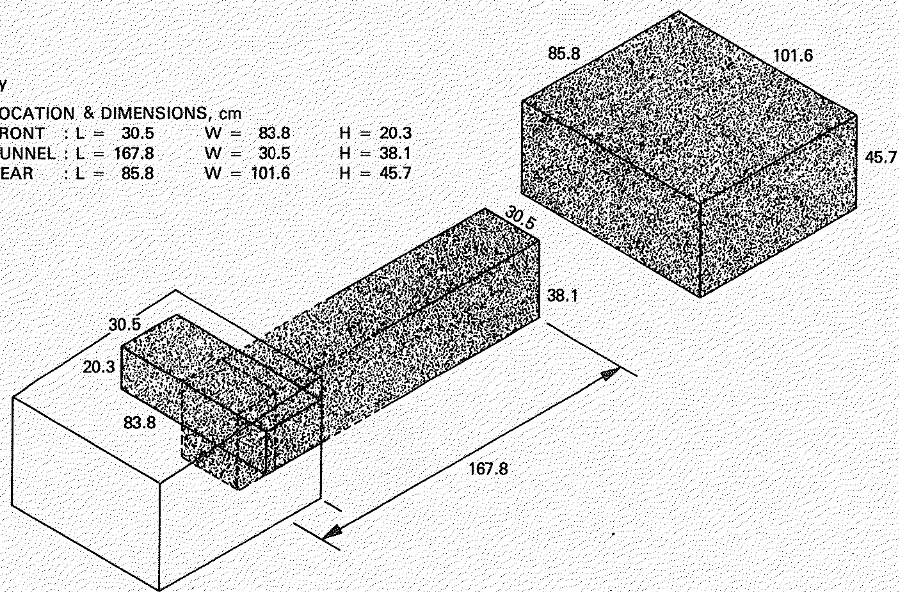
160-km $Zn\text{-}Cl_2$ EV
5 - Passenger

		Battery		
WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm		
406	456	FRONT		
		TUNNEL : L = 157	W = 30.5	H = 38.1
		REAR : L = 91.4	W = 78.7	H = 38.1



240-km Fe-Air EV
5 - Passenger

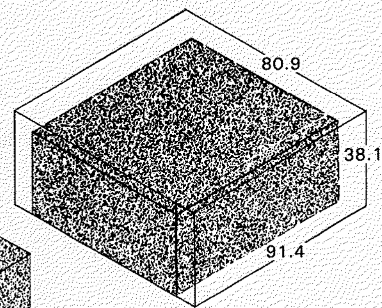
		Battery		
WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm		
704	640	FRONT : L = 30.5	W = 83.8	H = 20.3
		TUNNEL : L = 167.8	W = 30.5	H = 38.1
		REAR : L = 85.8	W = 101.6	H = 45.7

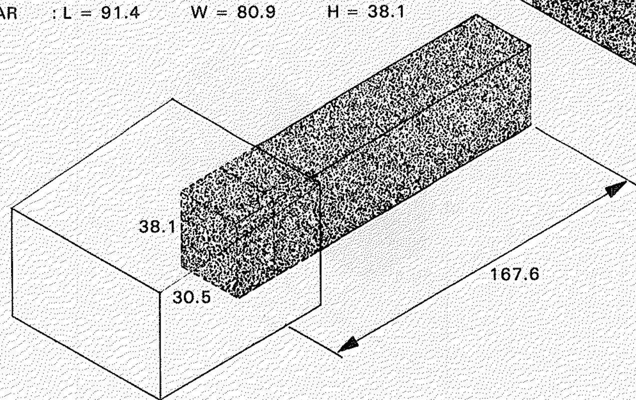


240-km Pb-Acid EV
5 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
1001	477	FRONT			
		TUNNEL	: L = 167.6	W = 30.5	H = 38.1
		REAR	: L = 91.4	W = 80.9	H = 38.1

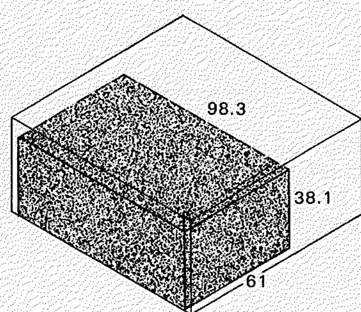


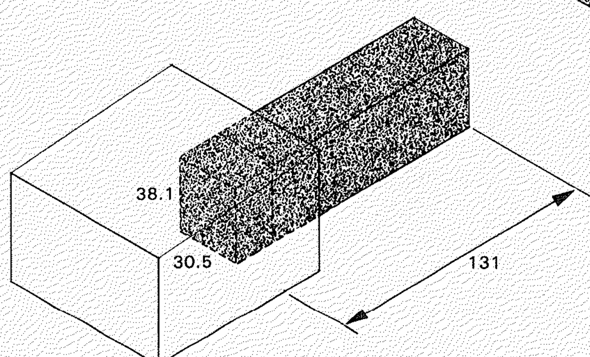


240-km Pb-Acid
Bipolar EV
5 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
754	381	FRONT			
		TUNNEL	: L = 131	W = 30.5	H = 38.1
		REAR	: L = 61	W = 98.3	H = 38.1

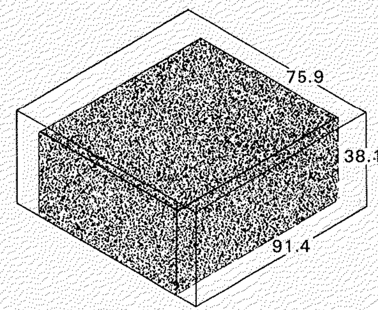


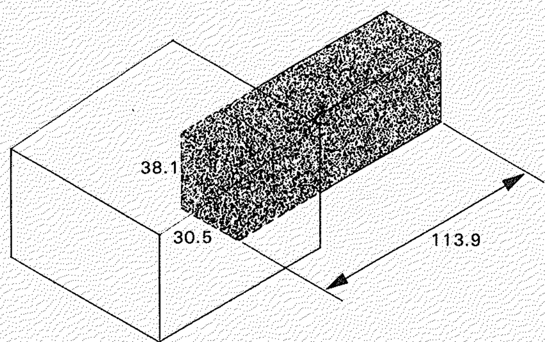


240-km Ni-Fe EV
5 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
664	397	FRONT			
		TUNNEL	: L = 113.9	W = 30.5	H = 38.1
		REAR	: L = 91.4	W = 75.9	H = 38.1

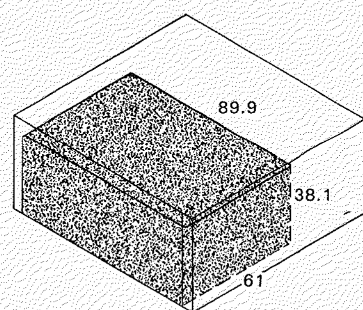


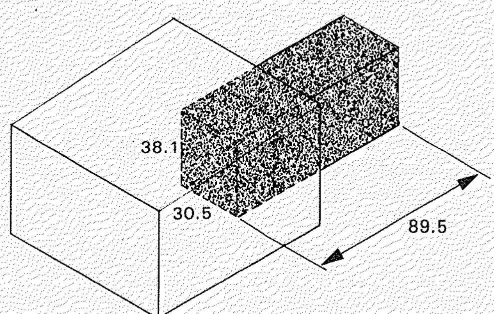


240-km Ni-Zn EV
5 - Passenger

Battery

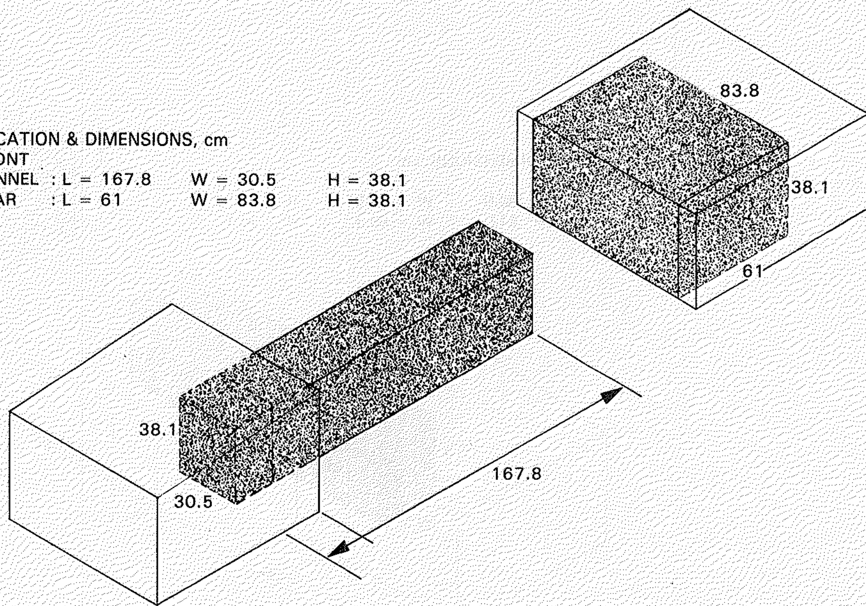
WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
522	313	FRONT			
		TUNNEL	: L = 35.4	W = 30.5	H = 38.1
		REAR	: L = 61	W = 89.9	H = 38.1





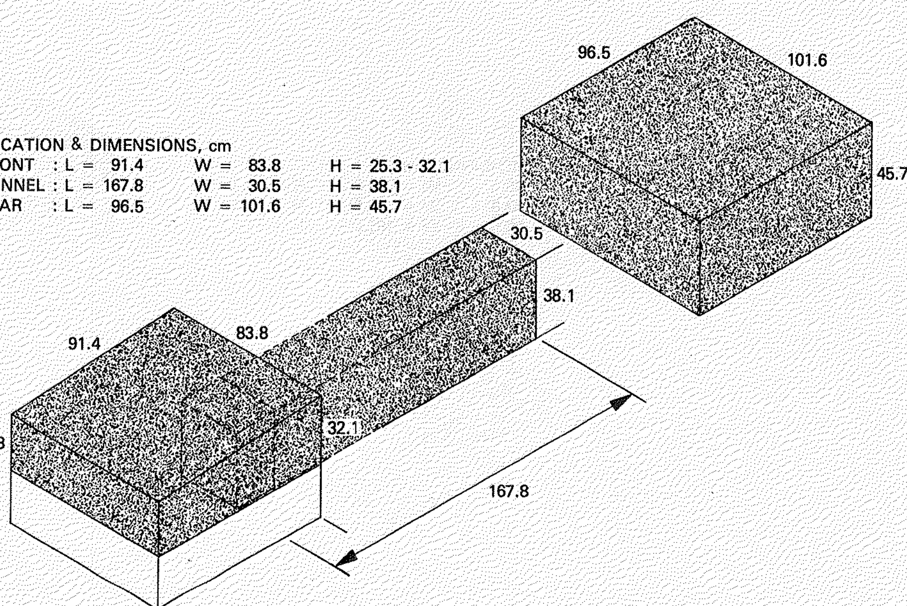
240-km Na-S EV
5 - Passenger

WEIGHT, kg	VOLUME, ℓ	Battery LOCATION & DIMENSIONS, cm			
352	390	FRONT			
		TUNNEL	: L = 167.8	W = 30.5	H = 38.1
		REAR	: L = 61	W = 83.8	H = 38.1



240-km Zn-Br_2 EV
5 - Passenger

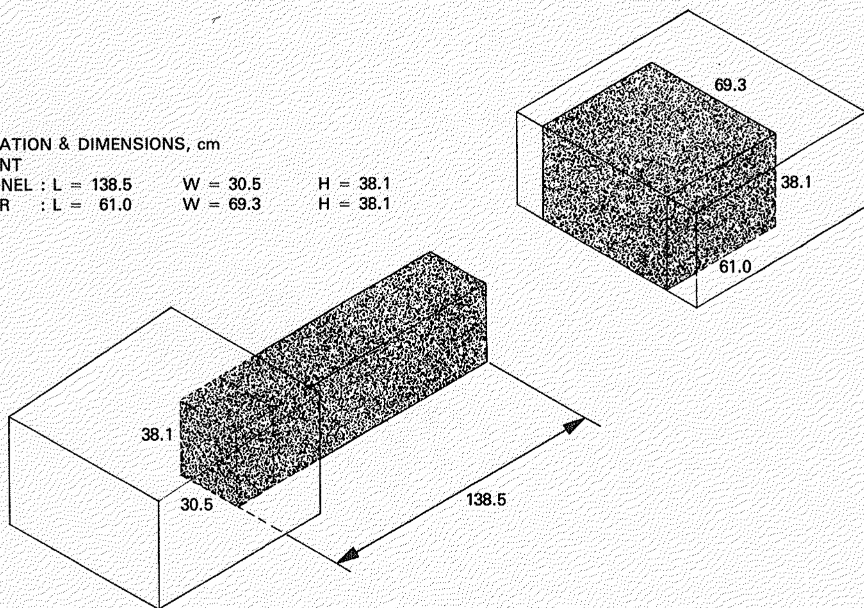
WEIGHT, kg	VOLUME, ℓ	Battery LOCATION & DIMENSIONS, cm			
1001	863	FRONT	: L = 91.4	W = 83.8	H = 25.3 - 32.1
		TUNNEL	: L = 167.8	W = 30.5	H = 38.1
		REAR	: L = 96.5	W = 101.6	H = 45.7



240-km Li-FeS EV
5 - Passenger

Battery

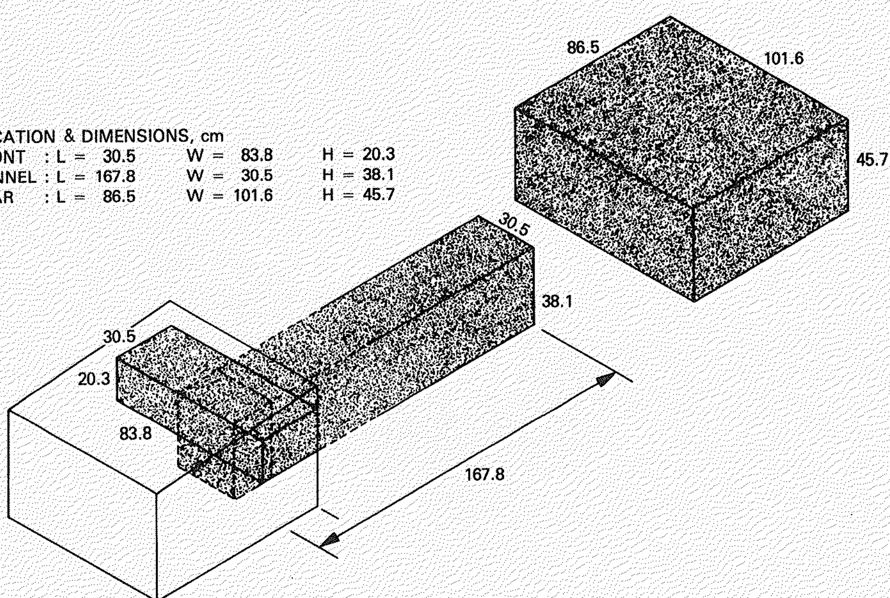
WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
451	322	FRONT			
		TUNNEL	: L = 138.5	W = 30.5	H = 38.1
		REAR	: L = 61.0	W = 69.3	H = 38.1



240-km $Zn-Cl_2$ EV
5 - Passenger

Battery

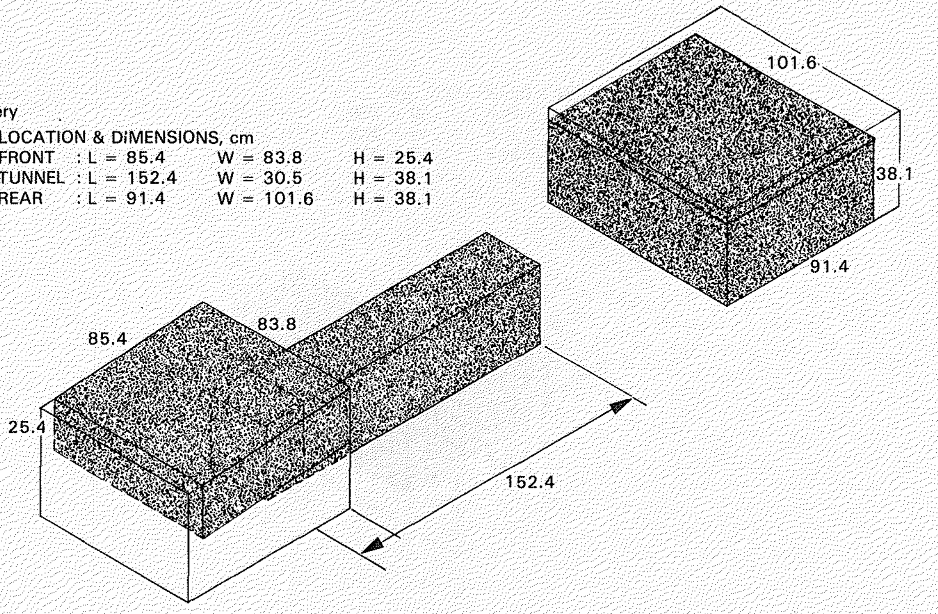
WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
746	643	FRONT	: L = 30.5	W = 83.8	H = 20.3
		TUNNEL	: L = 167.8	W = 30.5	H = 38.1
		REAR	: L = 86.5	W = 101.6	H = 45.7



400-km Zn-Cl_2 EV
5 - Passenger

Battery

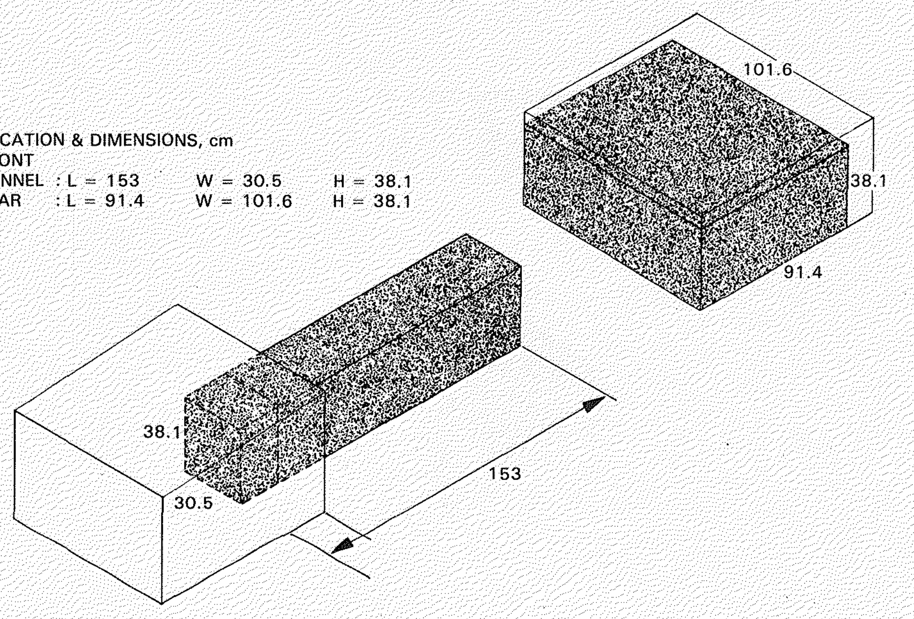
WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
889	713	FRONT	: L = 85.4	W = 83.8	H = 25.4
		TUNNEL	: L = 152.4	W = 30.5	H = 38.1
		REAR	: L = 91.4	W = 101.6	H = 38.1



400-km Fe-Air EV
5 - Passenger

Battery

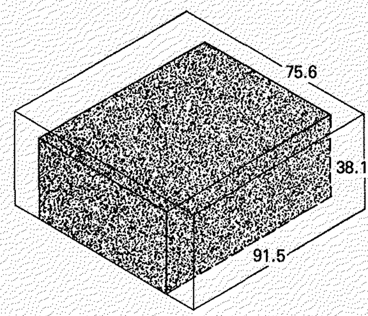
WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
724	533	FRONT			
		TUNNEL	: L = 153	W = 30.5	H = 38.1
		REAR	: L = 91.4	W = 101.6	H = 38.1

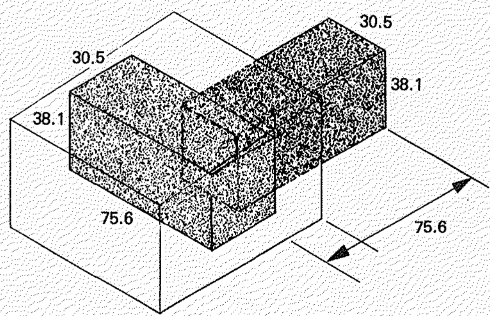


400-km Li-FeS EV
5 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
615	439	FRONT	: L = 30.5	W = 75.6	H = 38.1
		TUNNEL	: L = 75.6	W = 30.5	H = 38.1
		REAR	: L = 91.5	W = 75.6	H = 38.1

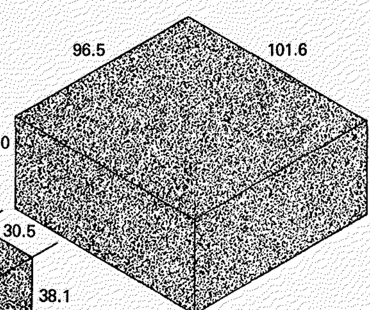


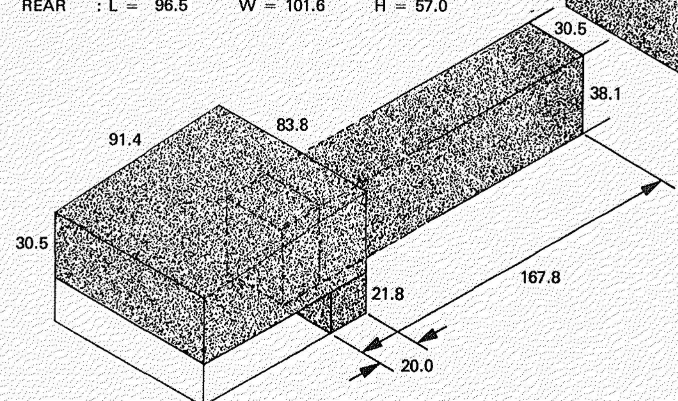


400-km Al -Air EV
5 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
		FRONT	: L = 91.4	W = 83.8	H = 30.0 (See Fig.)
		TUNNEL	: L = 167.8	W = 30.5	H = 38.1
		REAR	: L = 96.5	W = 101.6	H = 57.0

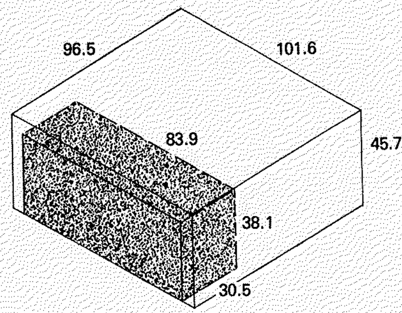


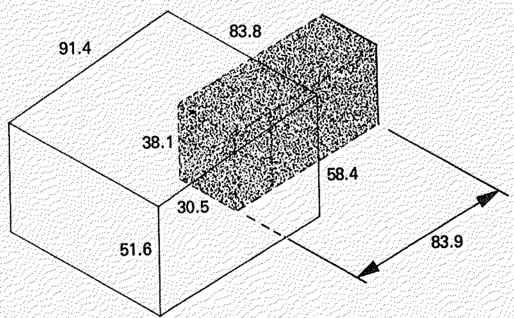


400-km Li-FeS Hyb
5 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm		
273	195	FRONT		
		TUNNEL : L = 83.9	W = 30.5	H = 38.1
		REAR : L = 30.5	W = 83.9	H = 38.1

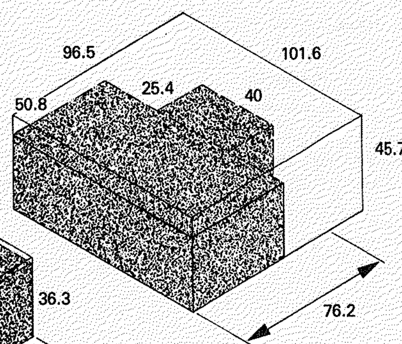


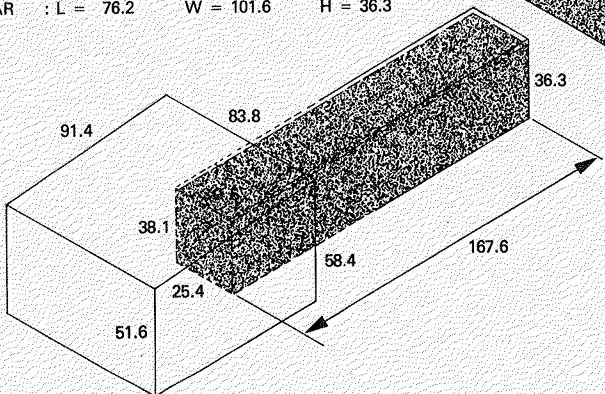


400-km Na-S Hyb
5 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm		
437	398	FRONT		
		TUNNEL : L = 167.6	W = 25.4	H = 36.3
		REAR : L = 76.2	W = 101.6	H = 36.3

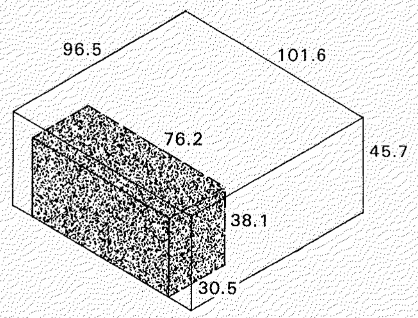


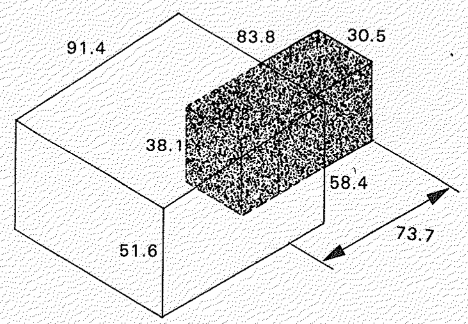


400-km Pb-Acid Hyb
5 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
411	174	FRONT			
		TUNNEL	: L = 73.7	W = 30.5	H = 38.1
		REAR	: L = 30.5	W = 76.2	H = 38.1

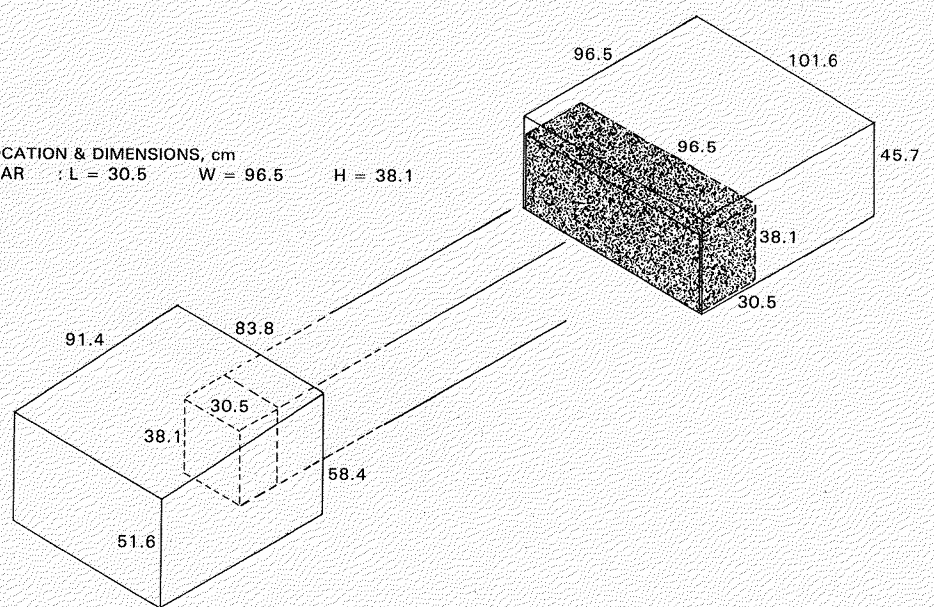




400-km Pb-Acid Hyb
Bipolar
5 - Passenger

Battery

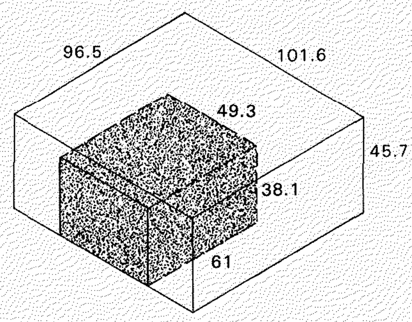
WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
224	49	REAR	: L = 30.5	W = 96.5	H = 38.1

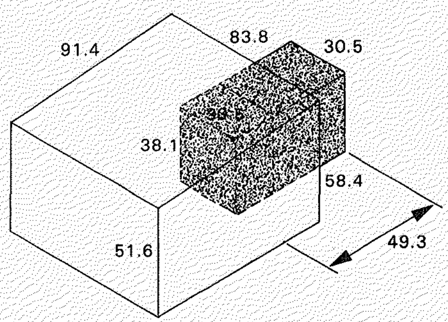


400-km Ni-Fe Hyb
5 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
333	172	FRONT			
		TUNNEL	: L = 49.3	W = 30.5	H = 38.1
		REAR	: L = 61	W = 49.3	H = 38.1

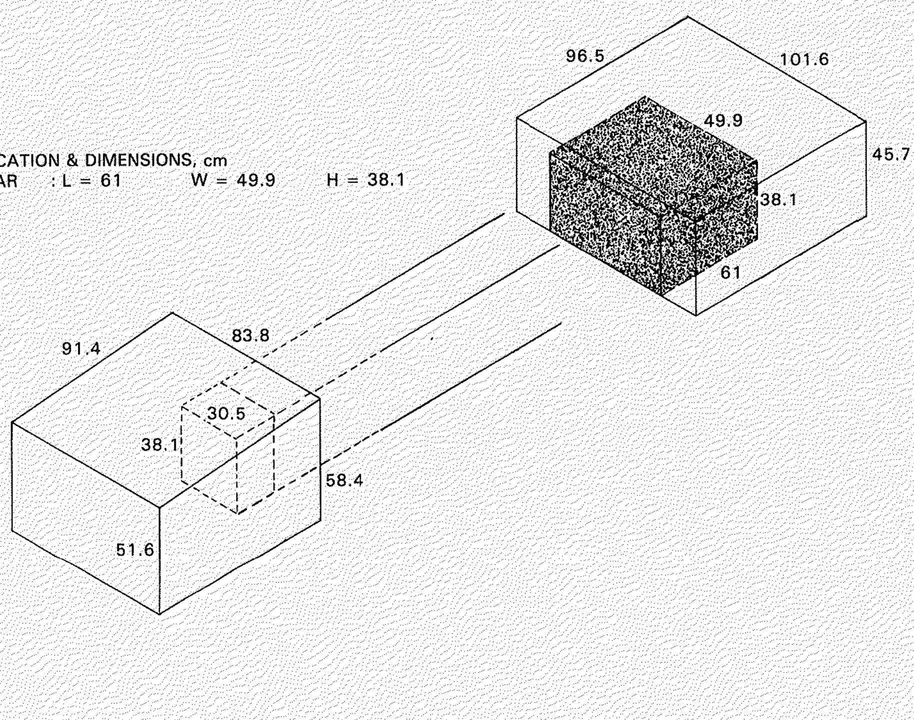




400-km Ni-Zn Hyb
5 - Passenger

Battery

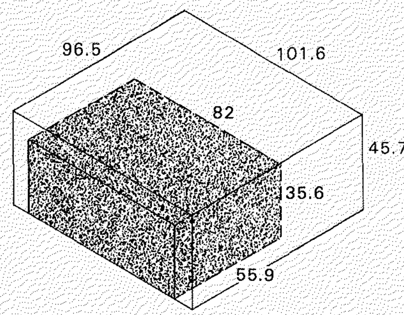
WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
229	137	REAR	: L = 61	W = 49.9	H = 38.1

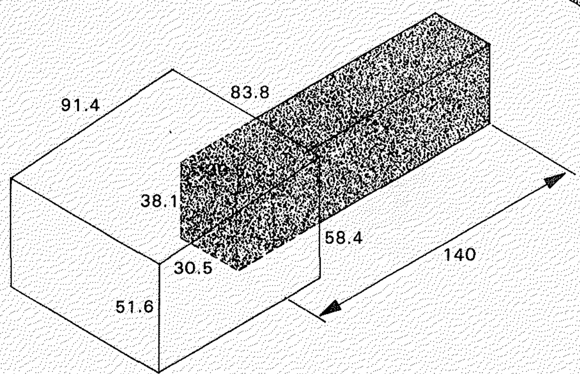


400-km Zn-Br_2 Hyb
5 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
432	326	FRONT			
		TUNNEL	: L = 140	W = 30.5	H = 38.1
		REAR	: L = 55.9	W = 82	H = 35.6

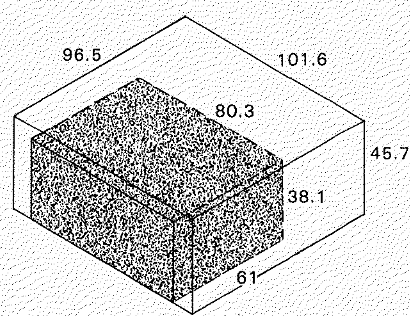


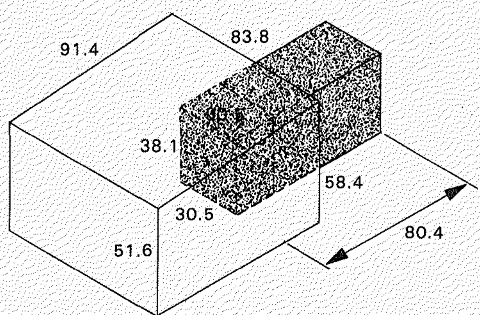


400-km Zn-$C\ell_2$ Hyb
5 - Passenger

Battery

WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
373	280	FRONT			
		TUNNEL	: L = 80.4	W = 30.5	H = 38.1
		REAR	: L = 61	W = 80.3	H = 38.1

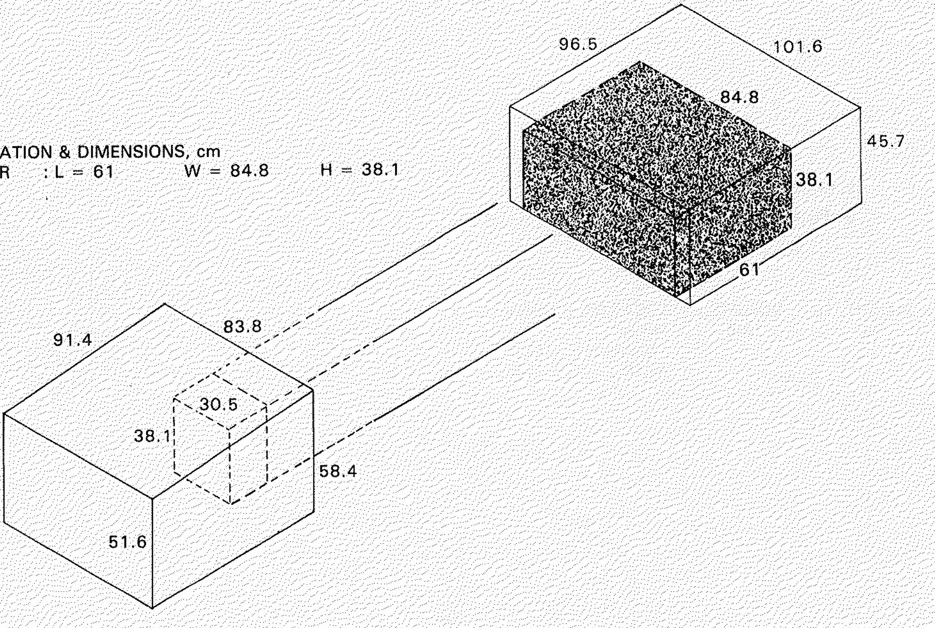




400-km Fe-Air Hyb 5 - Passenger

Battery

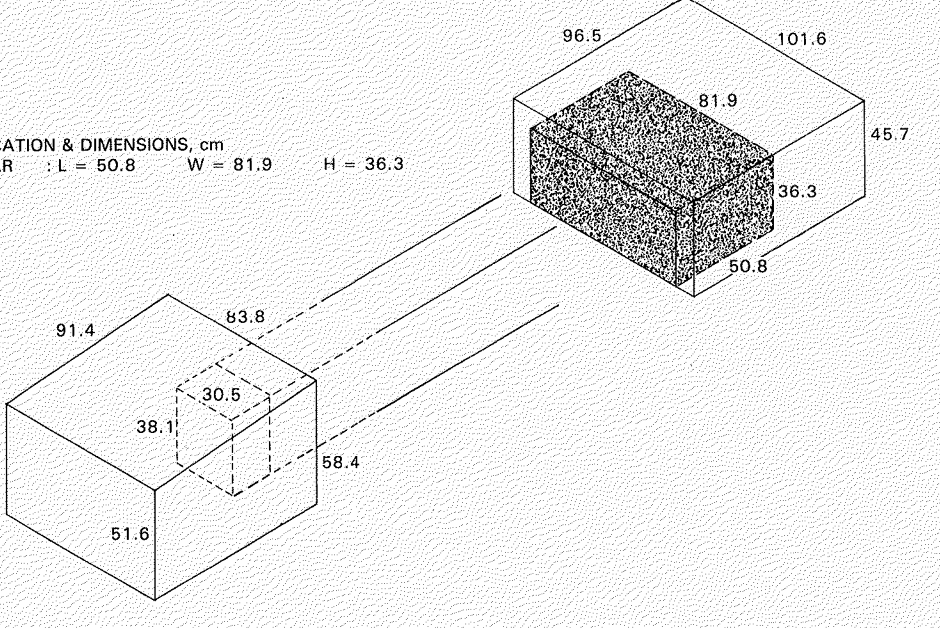
WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
284	197	REAR	: L = 61	W = 84.8	H = 38.1



400-km Na-S Hyb 5 - Passenger

Battery

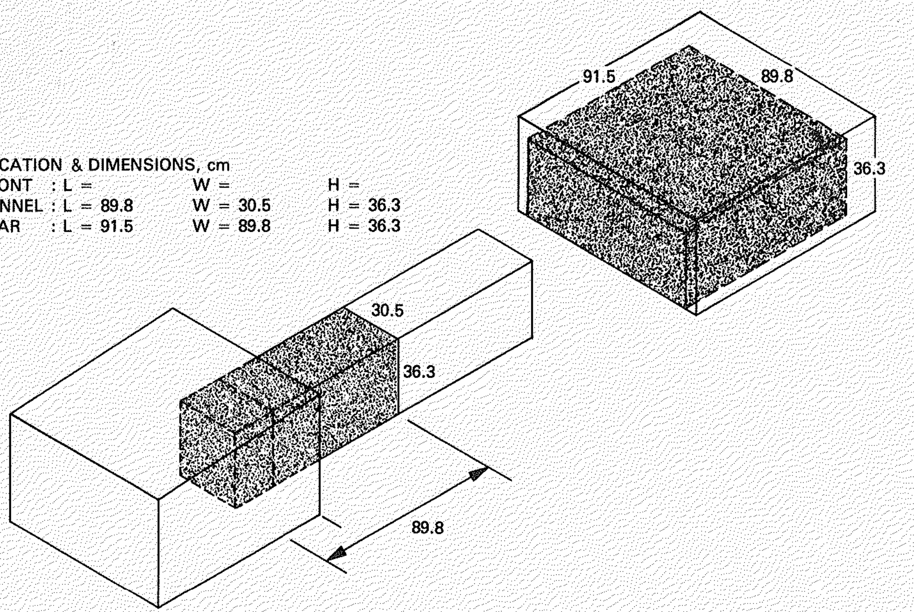
WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
167	151	REAR	: L = 50.8	W = 81.9	H = 36.3



400-km Na-S EV
5 - Passenger

Battery

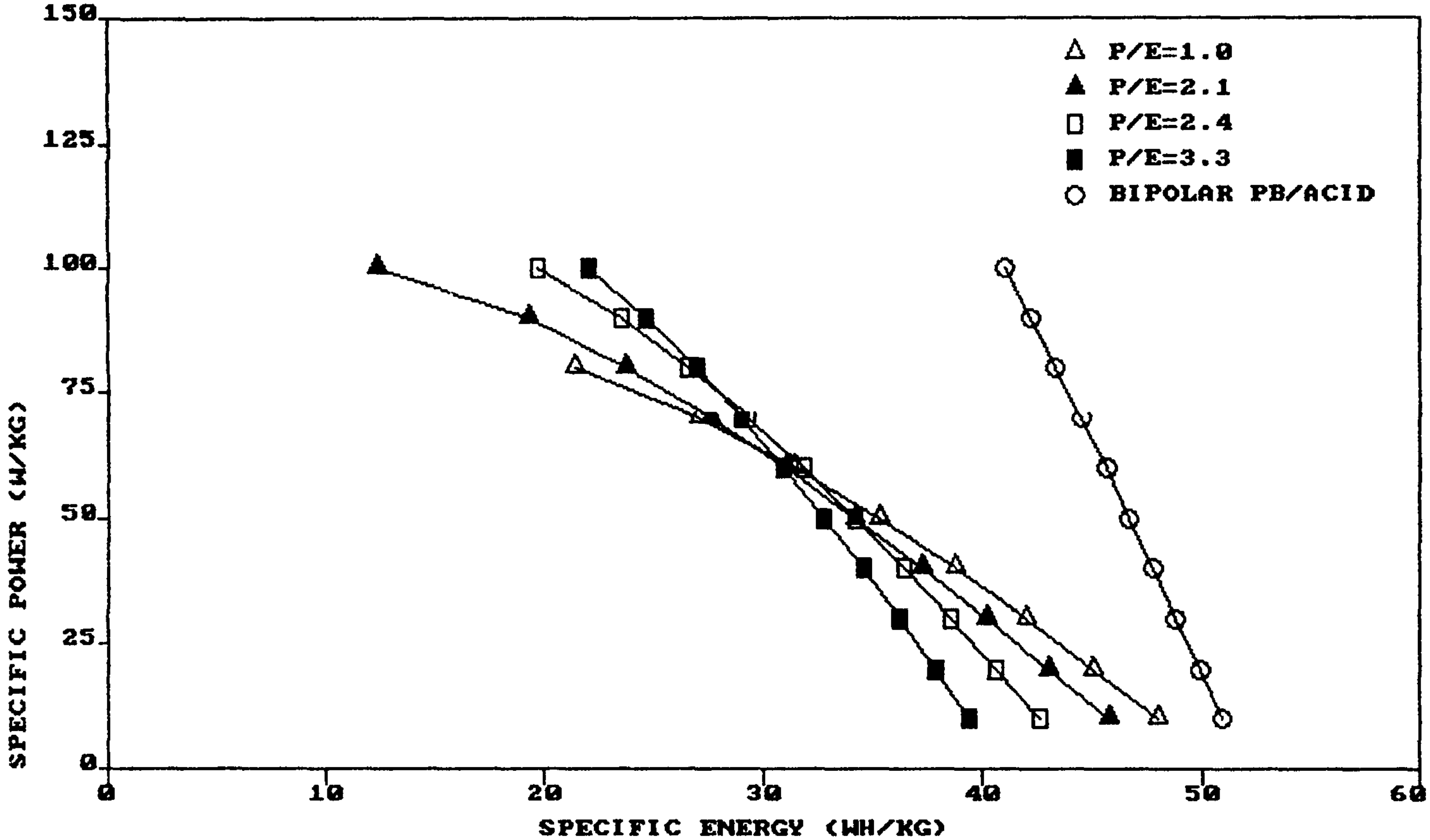
WEIGHT, kg	VOLUME, ℓ	LOCATION & DIMENSIONS, cm			
437	398	FRONT	: L =	W =	H =
		TUNNEL	: L = 89.8	W = 30.5	H = 36.3
		REAR	: L = 91.5	W = 89.8	H = 36.3

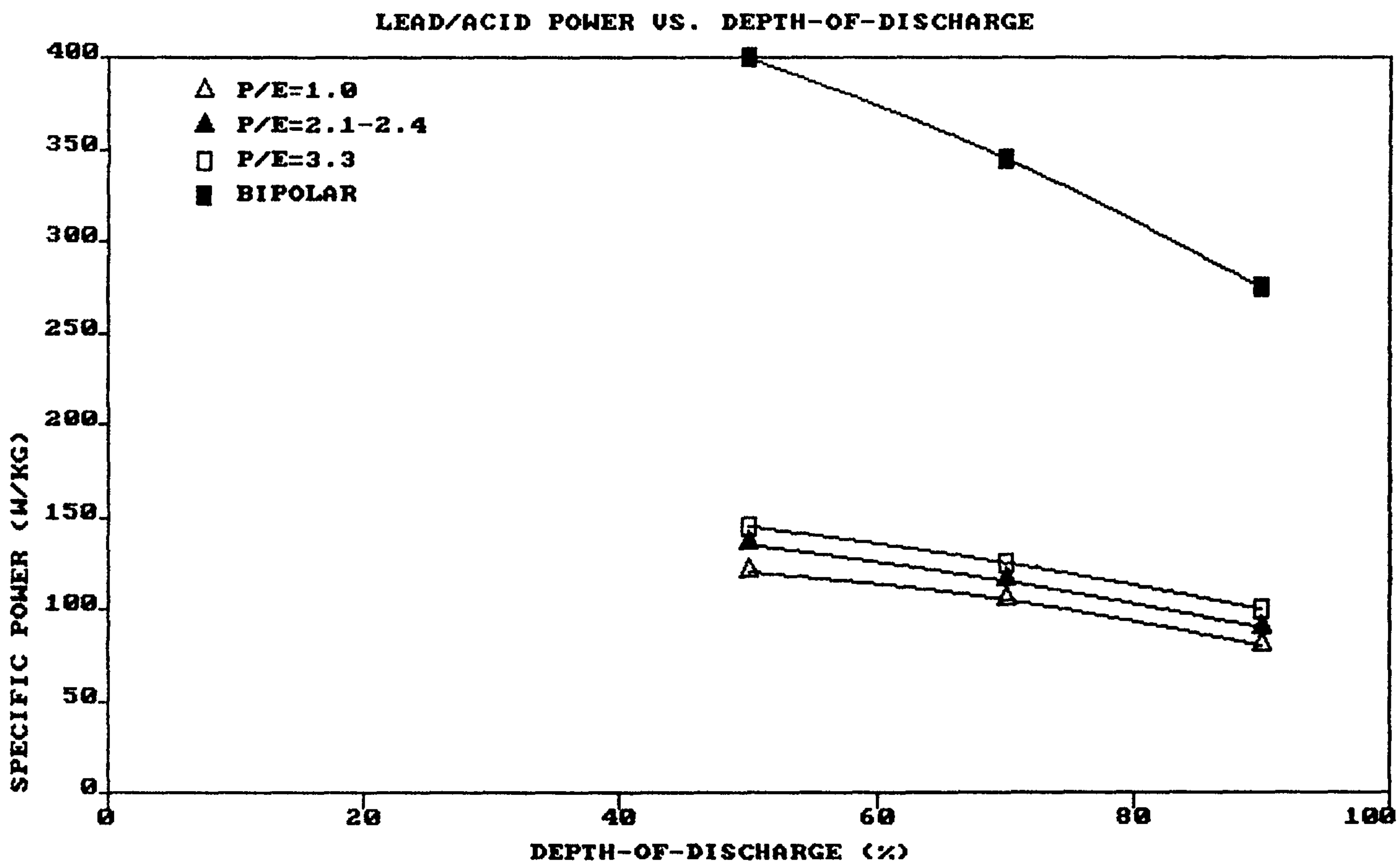


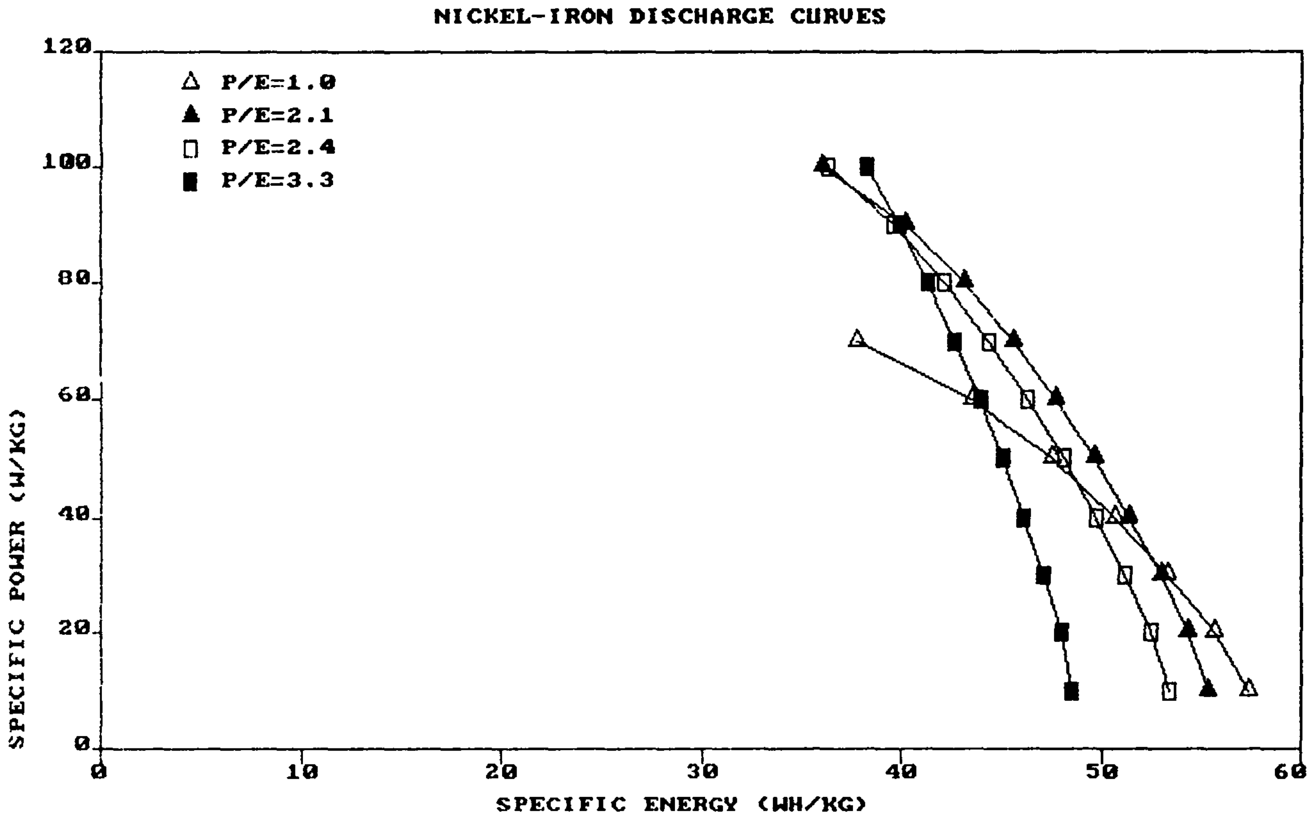
APPENDIX D

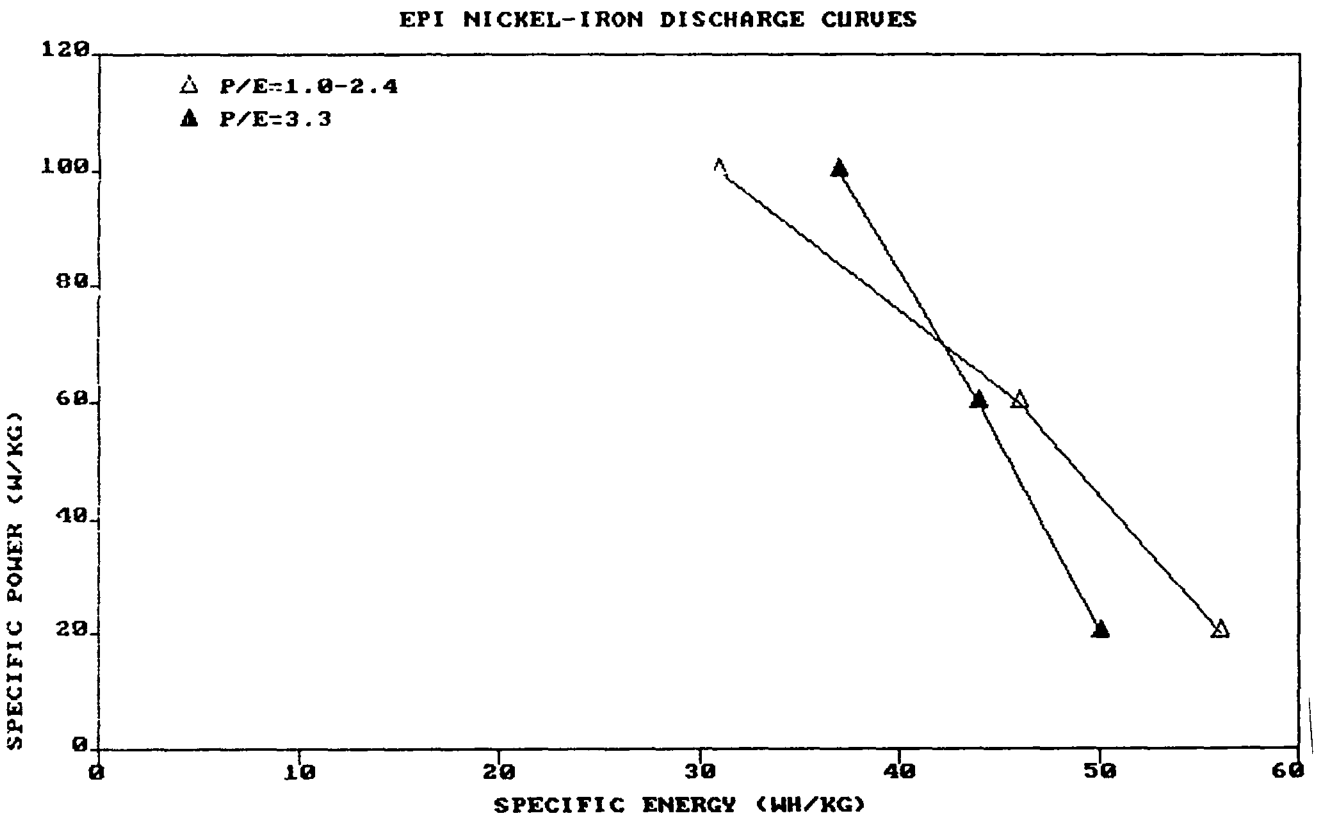
COMPARISON OF BATTERY PROJECTIONS

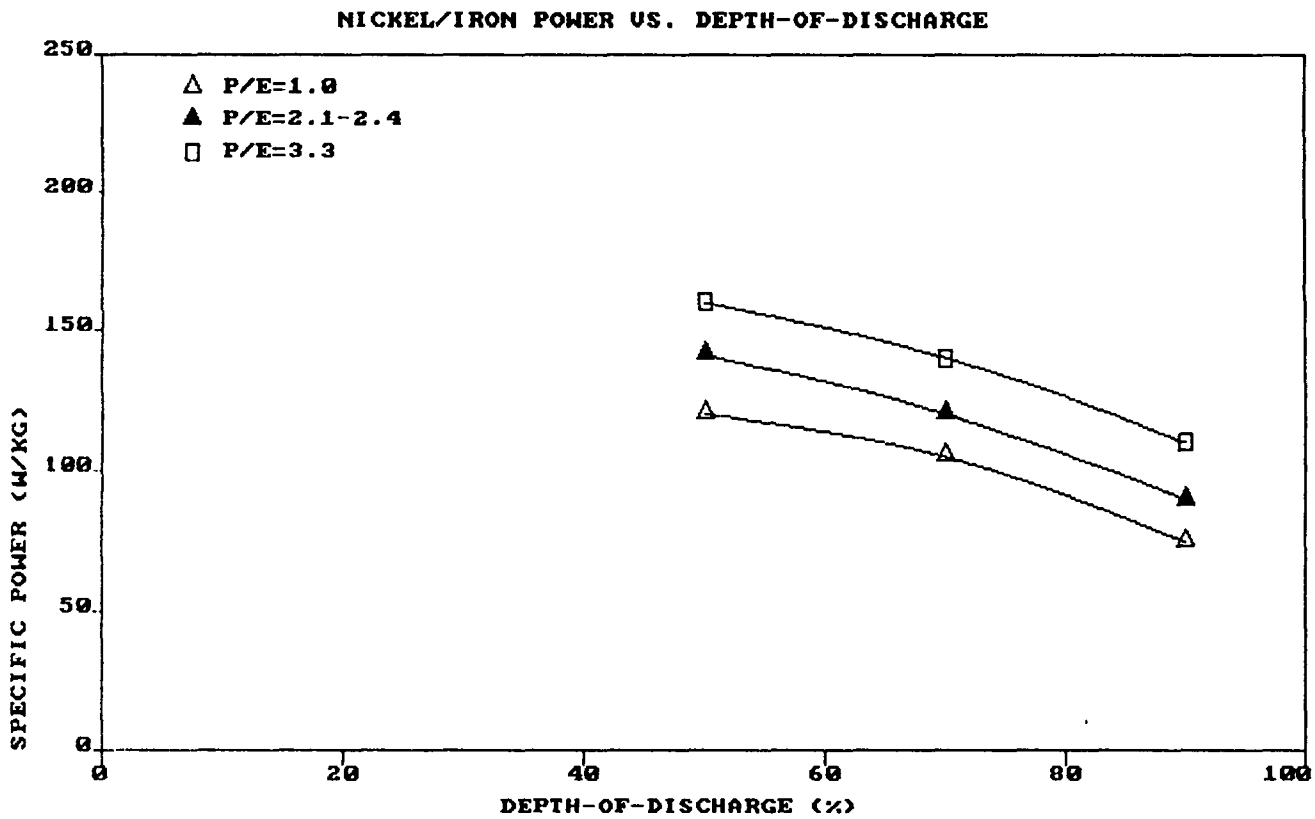
LEAD/ACID DISCHARGE CURVES

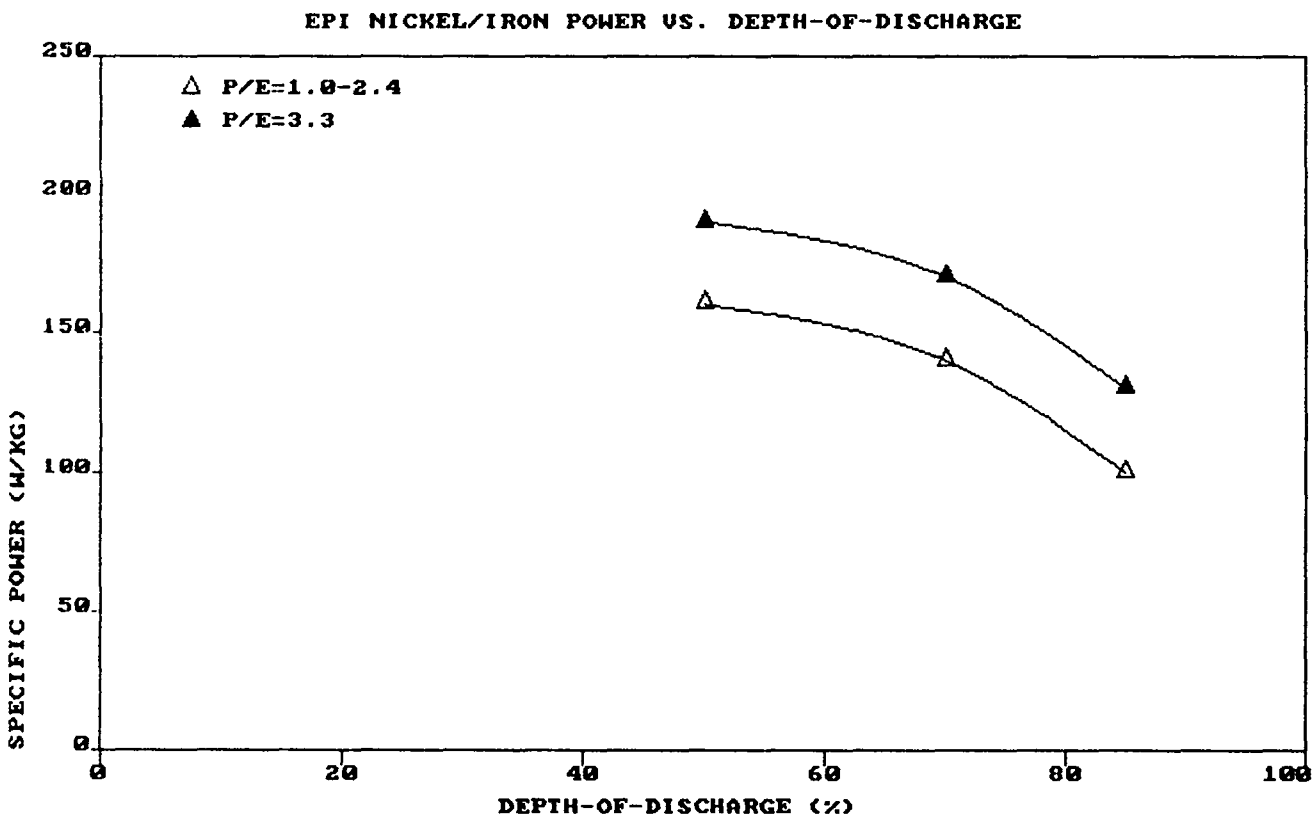


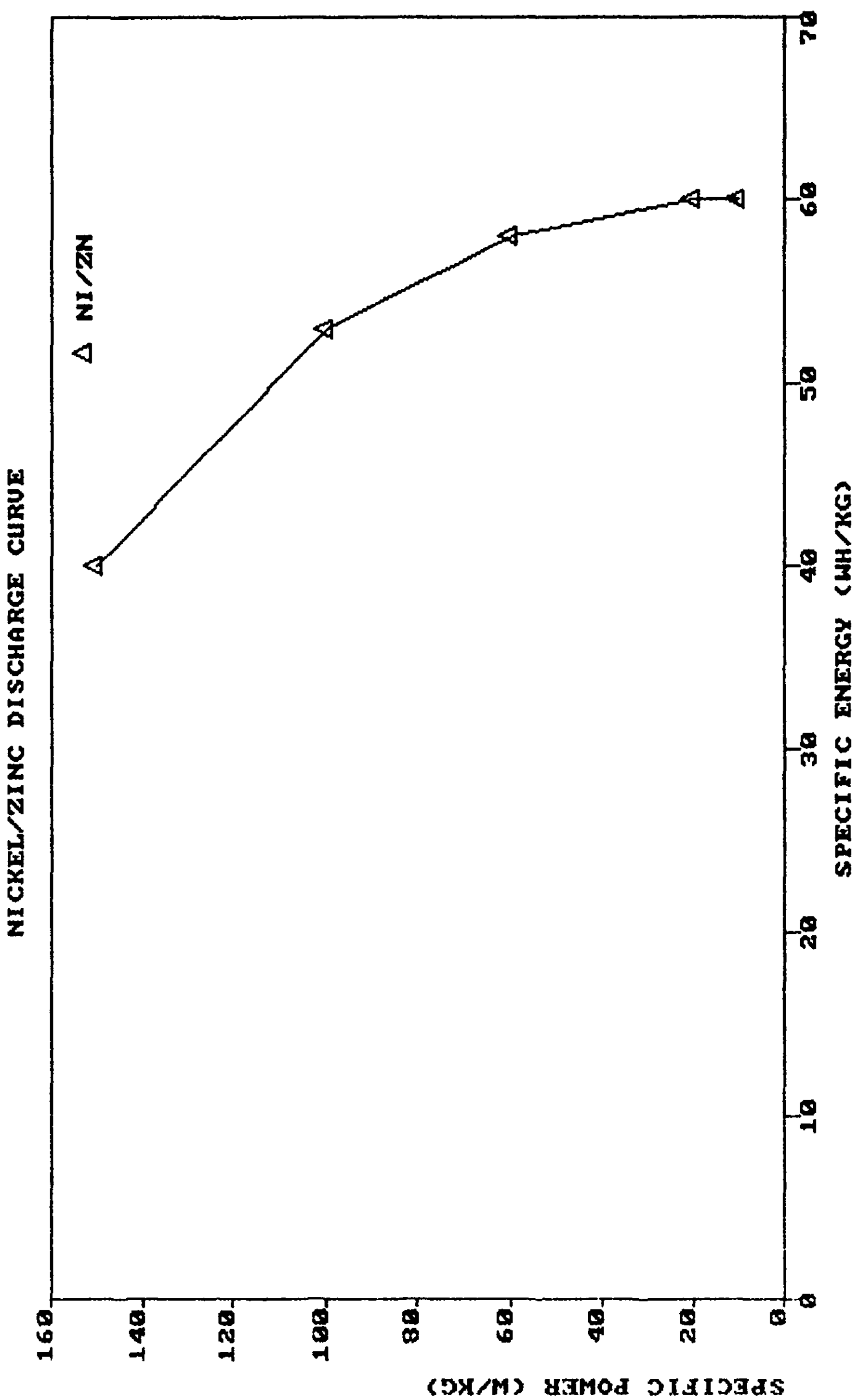

LEAD/ACID POWER VS. DEPTH-OF-DISCHARGE
P/E=1.0
P/E=2.1-2.4
P/E=3.3
BIPOLAR
SPECIFIC POWER (W/KG)
0
50
100
150
200
250
300
350
400
0
20
40
60
80
100
DEPTH-OF-DISCHARGE (%)

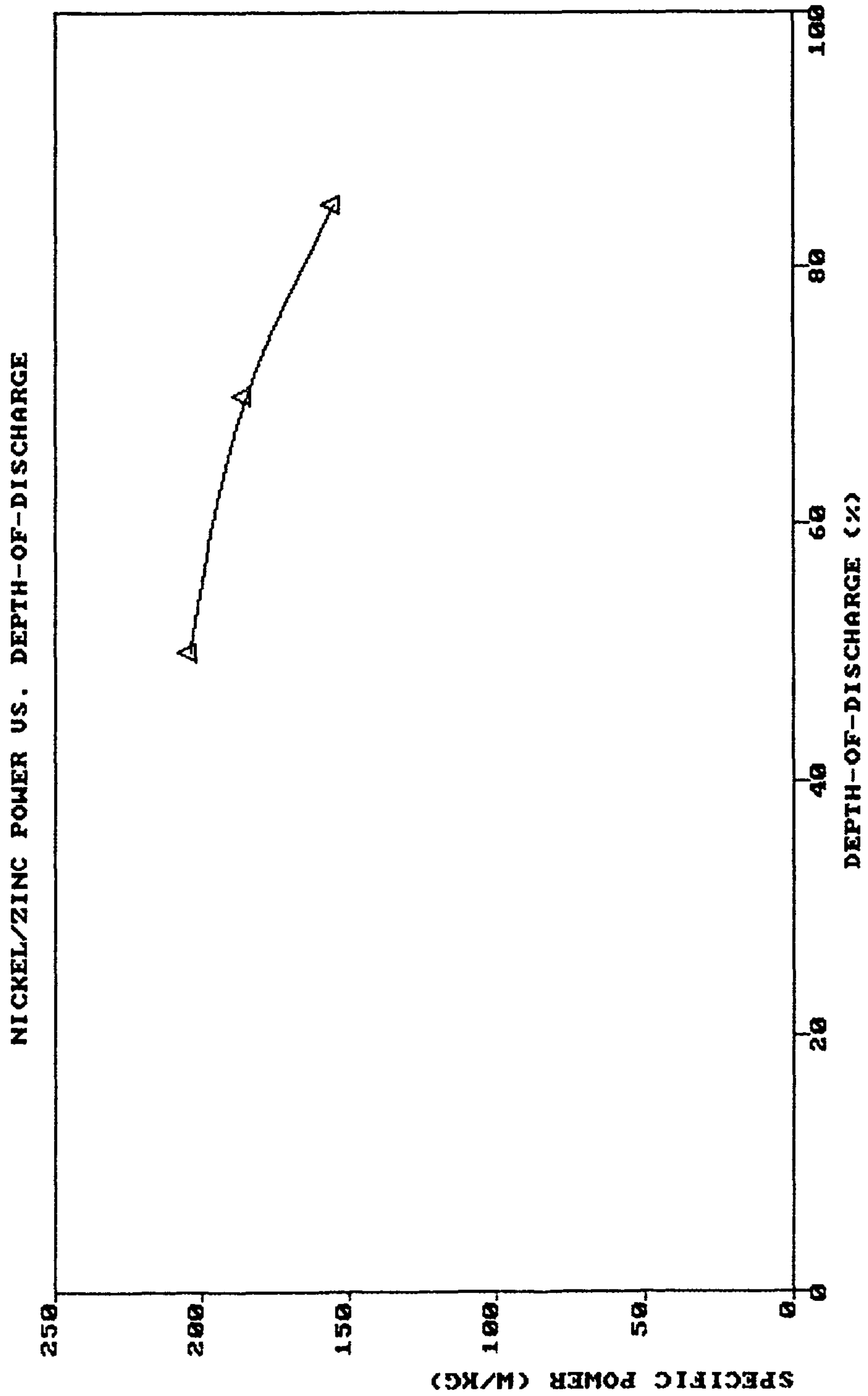

NICKEL-IRON DISCHARGE CURVES
P/E=1.0
P/E=2.1
P/E=2.4
P/E=3.3
SPECIFIC POWER (W/KG)
SPECIFIC ENERGY (WH/KG)
0
10
20
30
40
50
60
80
100
120


EPI NICKEL-IRON DISCHARGE CURVES
P/E=1.0-2.4
P/E=3.3
SPECIFIC POWER (W/KG)
SPECIFIC ENERGY (WH/KG)
0
10
20
30
40
50
60
80
100
120


NICKEL/IRON POWER VS. DEPTH-OF-DISCHARGE
P/E=1.0
P/E=2.1-2.4
P/E=3.3
SPECIFIC POWER (W/KG)
DEPTH-OF-DISCHARGE (%)
250
200
150
100
50
0
0
20
40
60
80
100

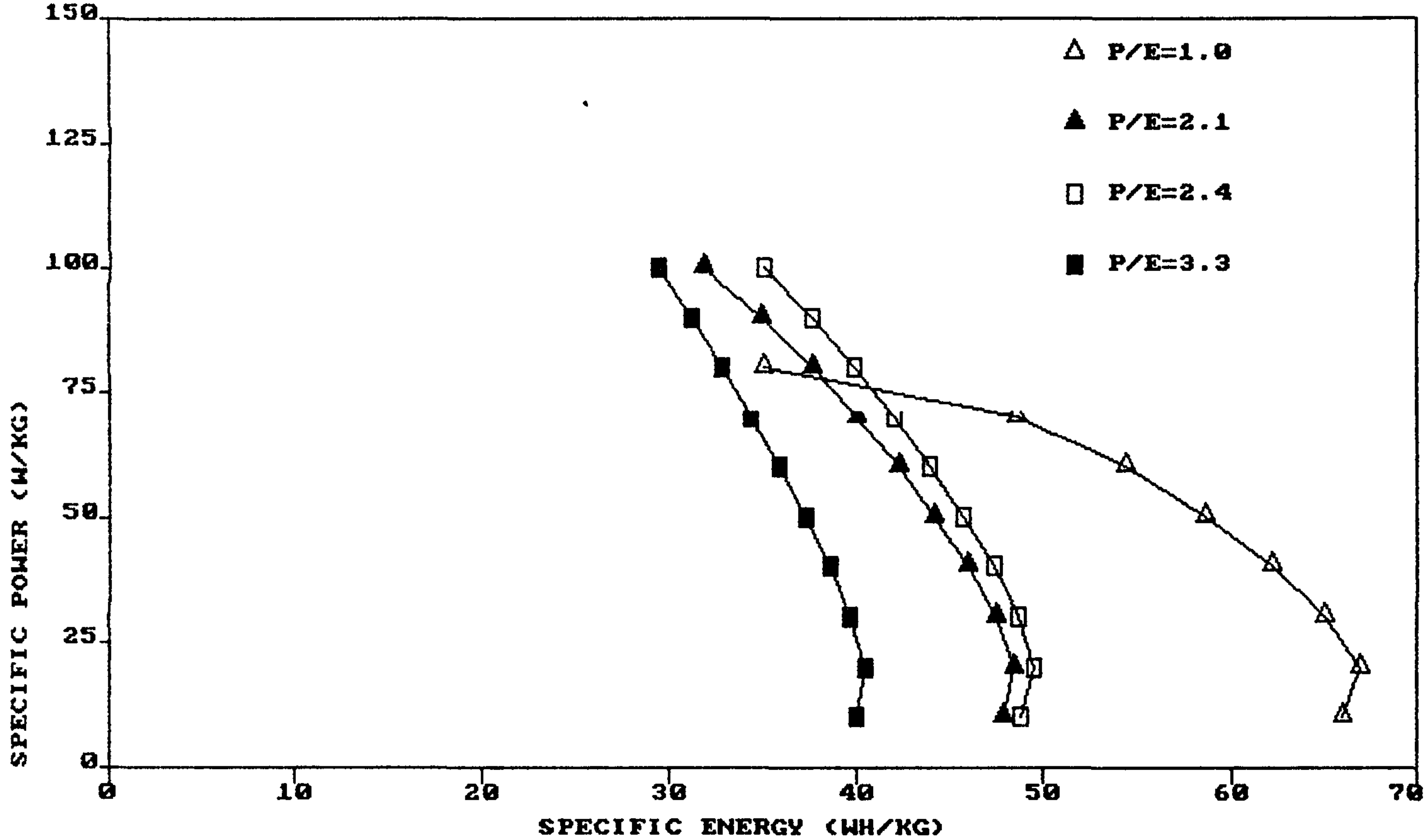

EPI NICKEL/IRON POWER VS. DEPTH-OF-DISCHARGE
P/E=1.0-2.4
P/E=3.3
SPECIFIC POWER (W/KG)
DEPTH-OF-DISCHARGE (%)
250
200
150
100
50
0
0
20
40
60
80
100

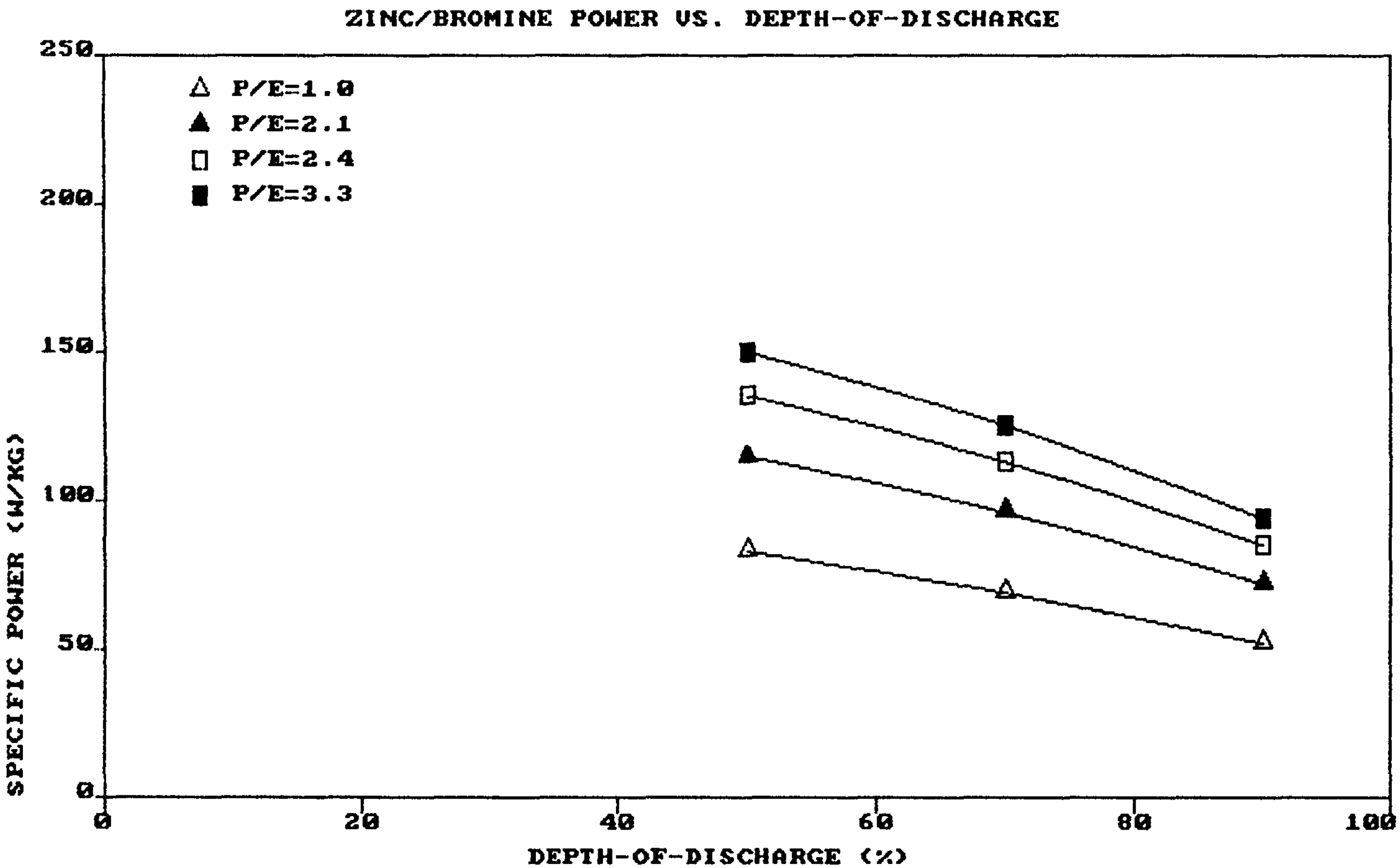

NICKEL/ZINC DISCHARGE CURVE
Δ NI/ZN
SPECIFIC POWER (W/KG)
SPECIFIC ENERGY (WH/KG)
0
20
40
60
80
100
120
140
160
0
10
20
30
40
50
60
70

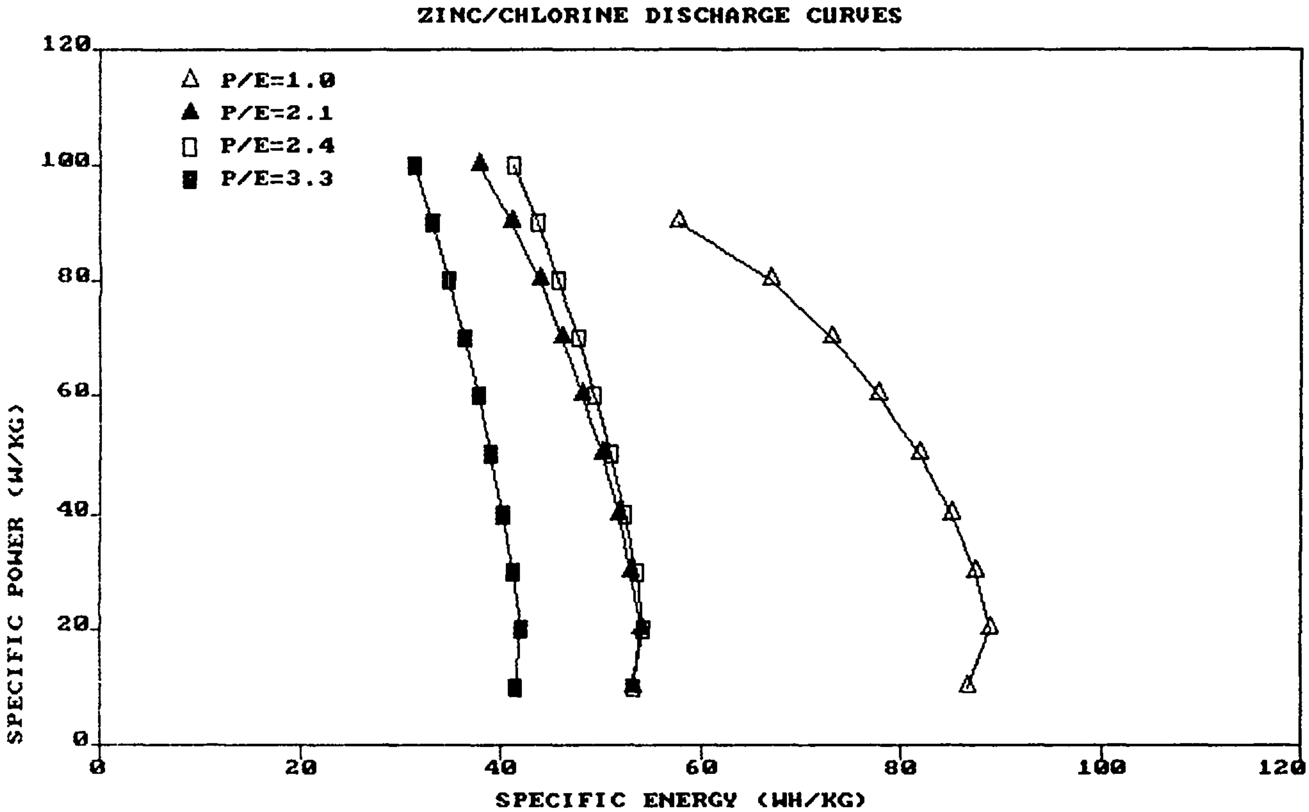


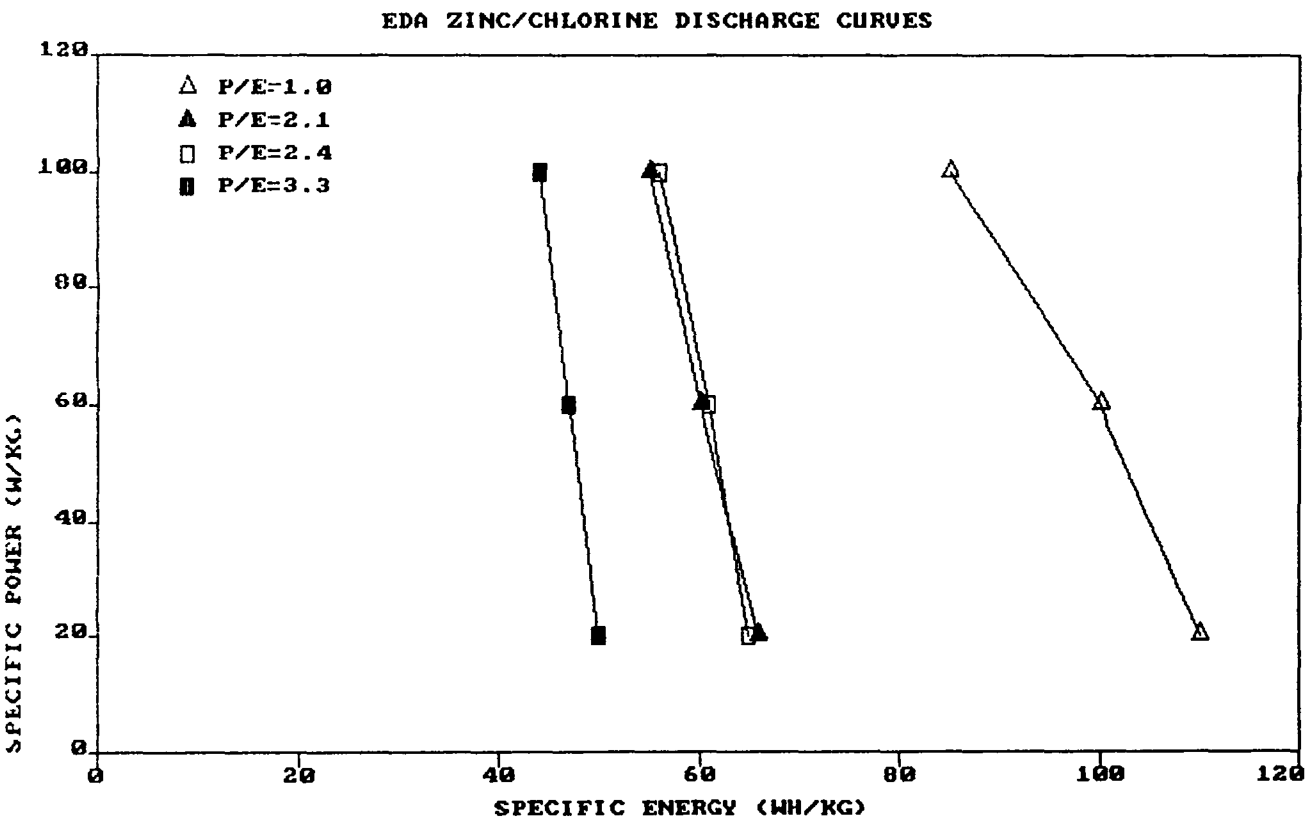
NICKEL/ZINC POWER VS. DEPTH-OF-DISCHARGE
SPECIFIC POWER (W/KG)
DEPTH-OF-DISCHARGE (%)
0
50
100
150
200
250
0
20
40
60
80
100

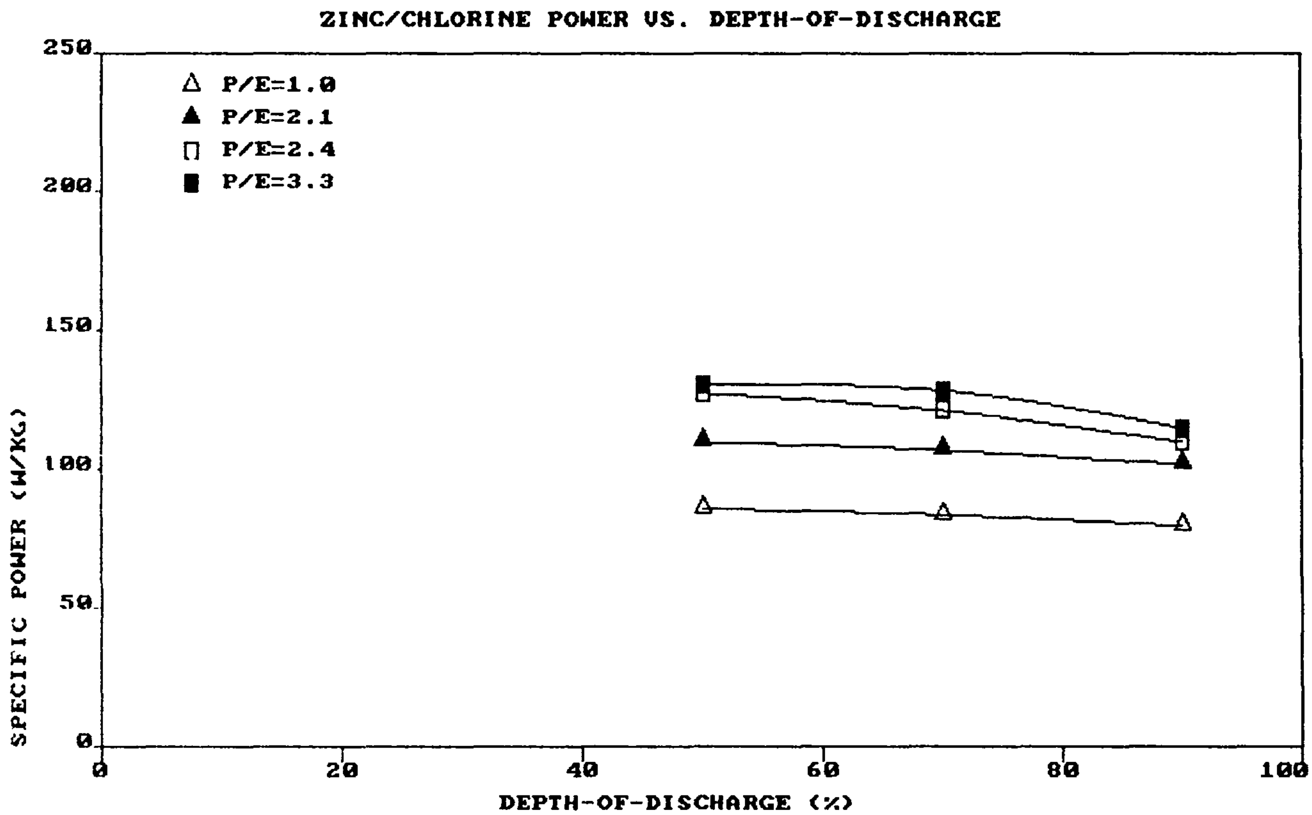
ZINC/BROMINE DISCHARGE CURVES

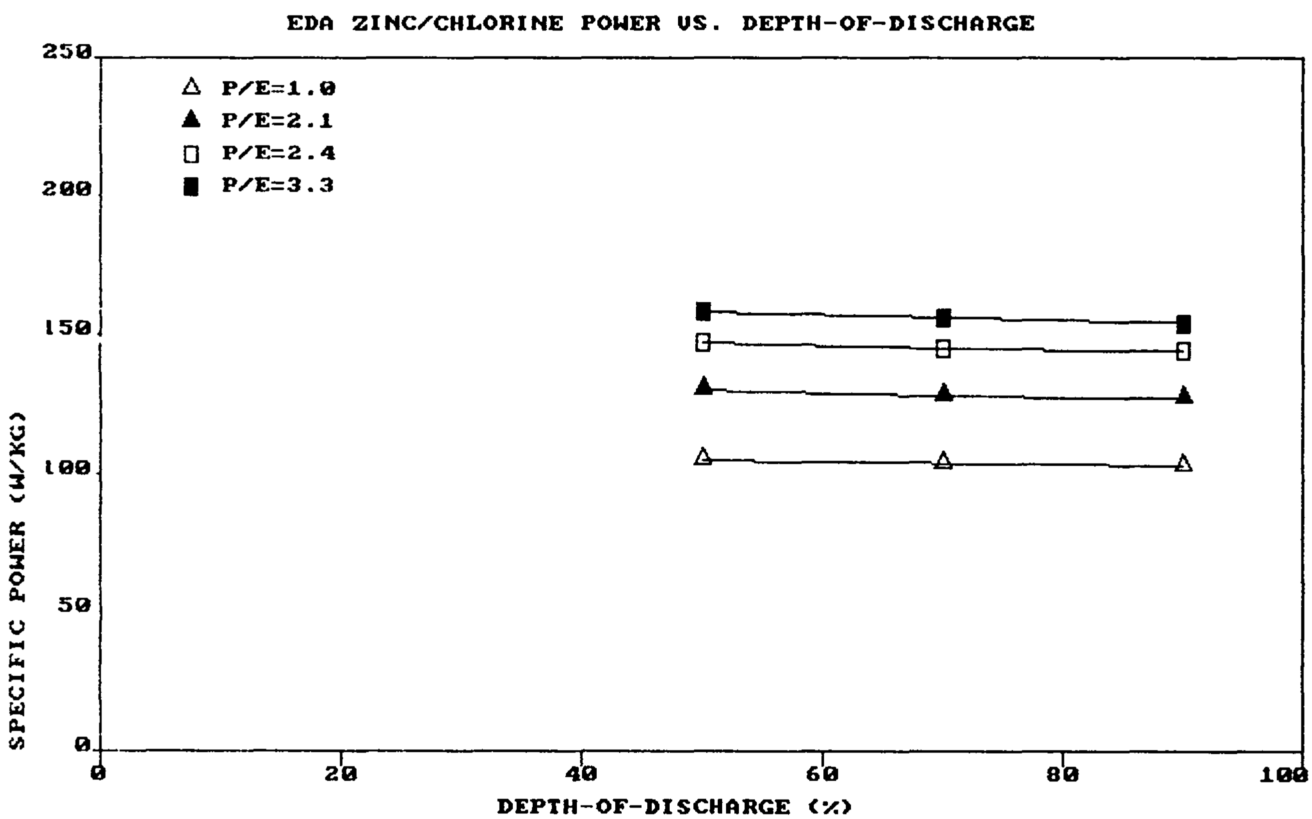


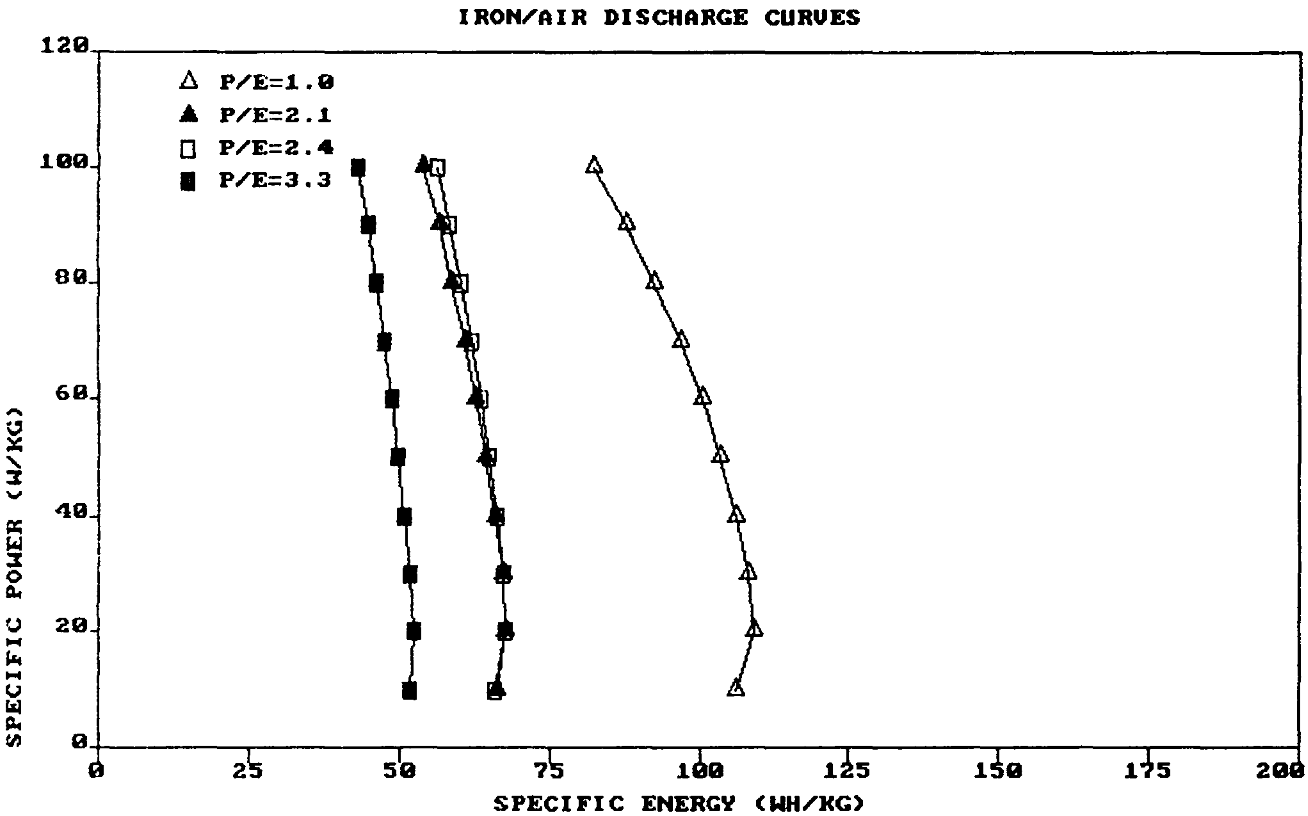

ZINC/BROMINE POWER VS. DEPTH-OF-DISCHARGE
P/E=1.0
P/E=2.1
P/E=2.4
P/E=3.3
SPECIFIC POWER (W/KG)
0
50
100
150
200
250
0
20
40
60
80
100
DEPTH-OF-DISCHARGE (%)

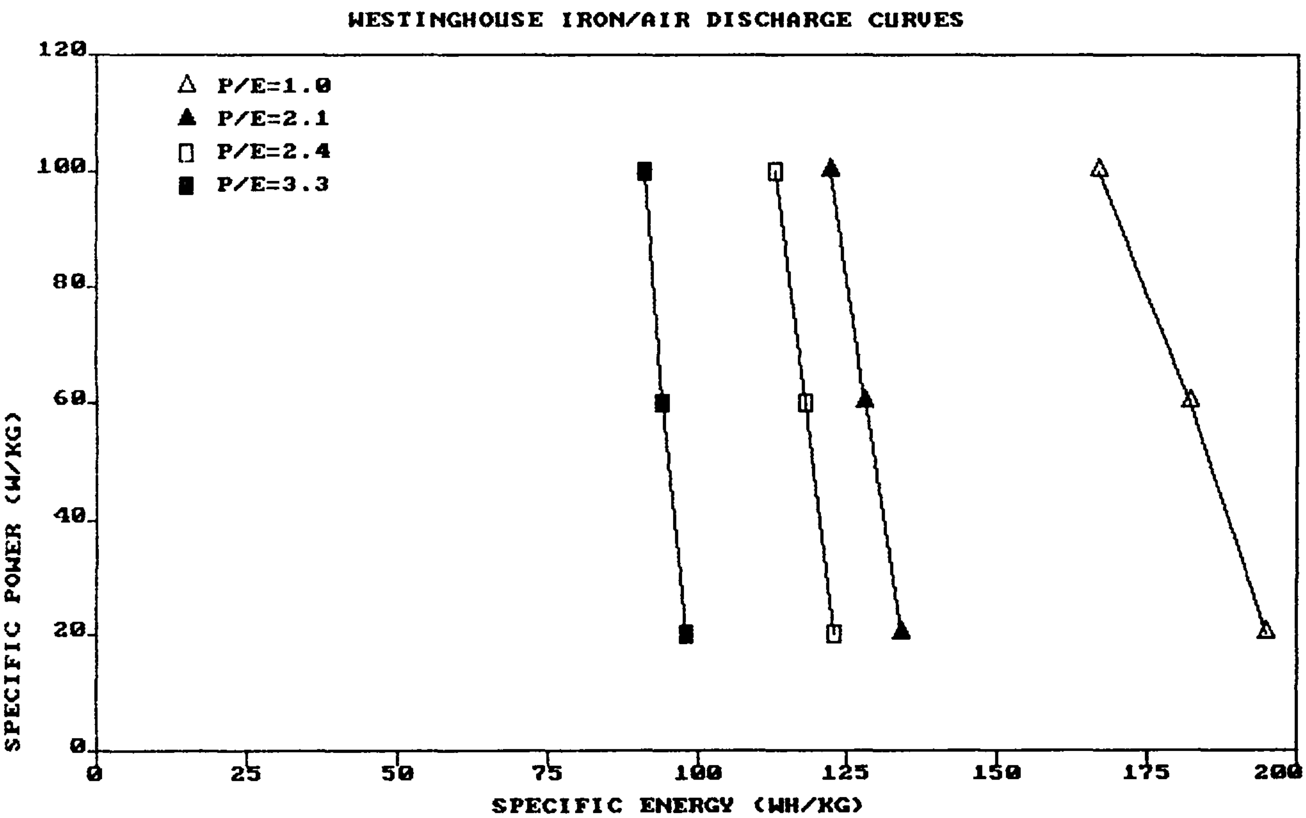

ZINC/CHLORINE DISCHARGE CURVES
P/E=1.0
P/E=2.1
P/E=2.4
P/E=3.3
SPECIFIC POWER (W/KG)
SPECIFIC ENERGY (WH/KG)
0
20
40
60
80
100
120

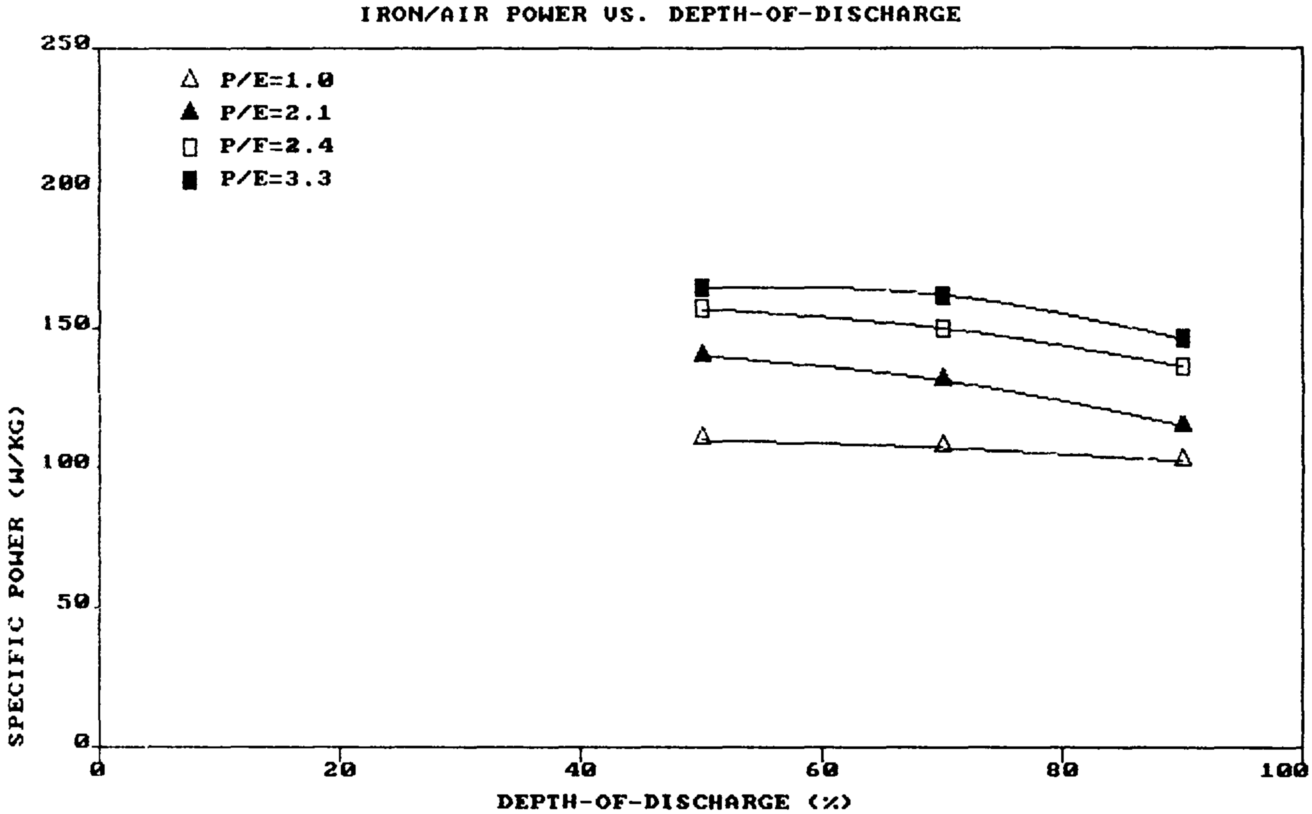

EDA ZINC/CHLORINE DISCHARGE CURVES
P/E=1.0
P/E=2.1
P/E=2.4
P/E=3.3
SPECIFIC POWER (W/KG)
SPECIFIC ENERGY (WH/KG)
0
20
40
60
80
100
120

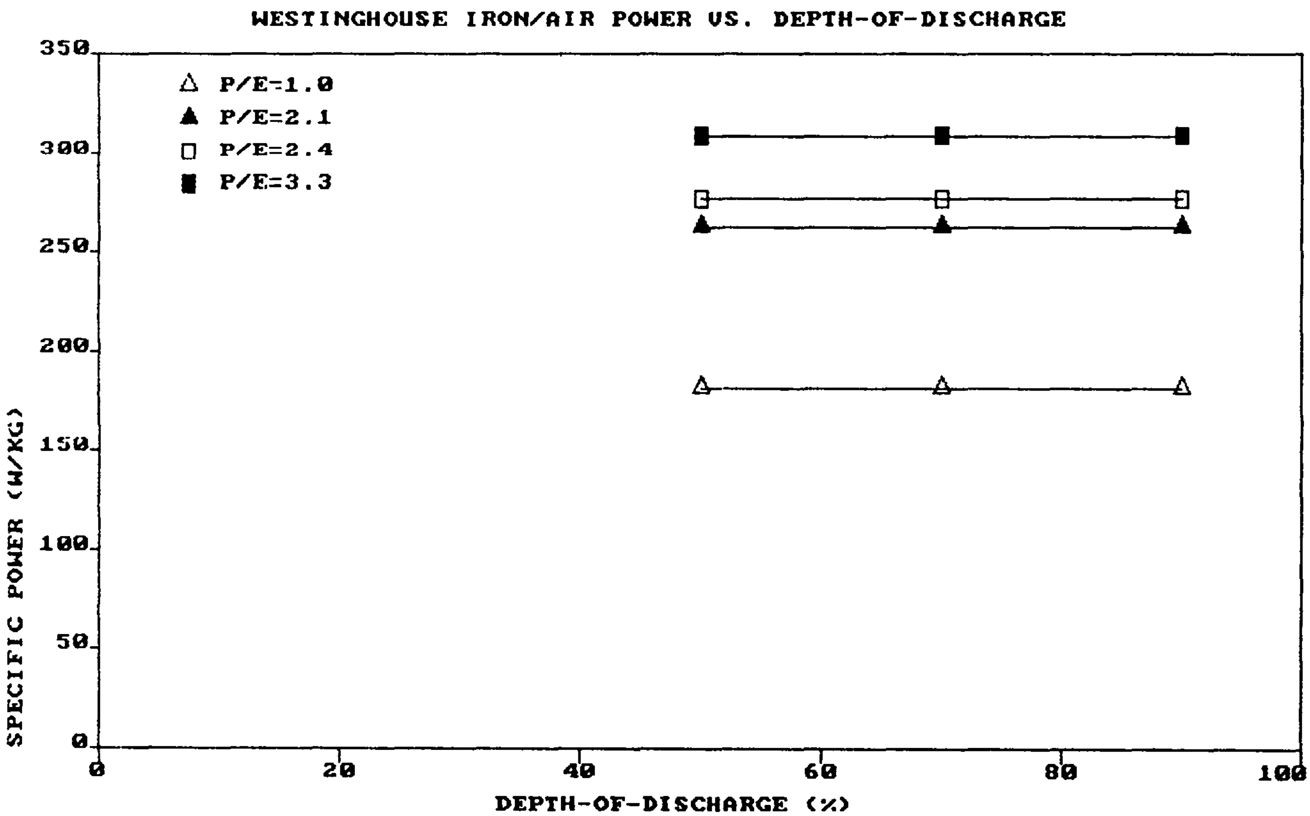

ZINC/CHLORINE POWER VS. DEPTH-OF-DISCHARGE
P/E=1.0
P/E=2.1
P/E=2.4
P/E=3.3
SPECIFIC POWER (W/KG)
DEPTH-OF-DISCHARGE (%)
0
50
100
150
200
250
0
20
40
60
80
100

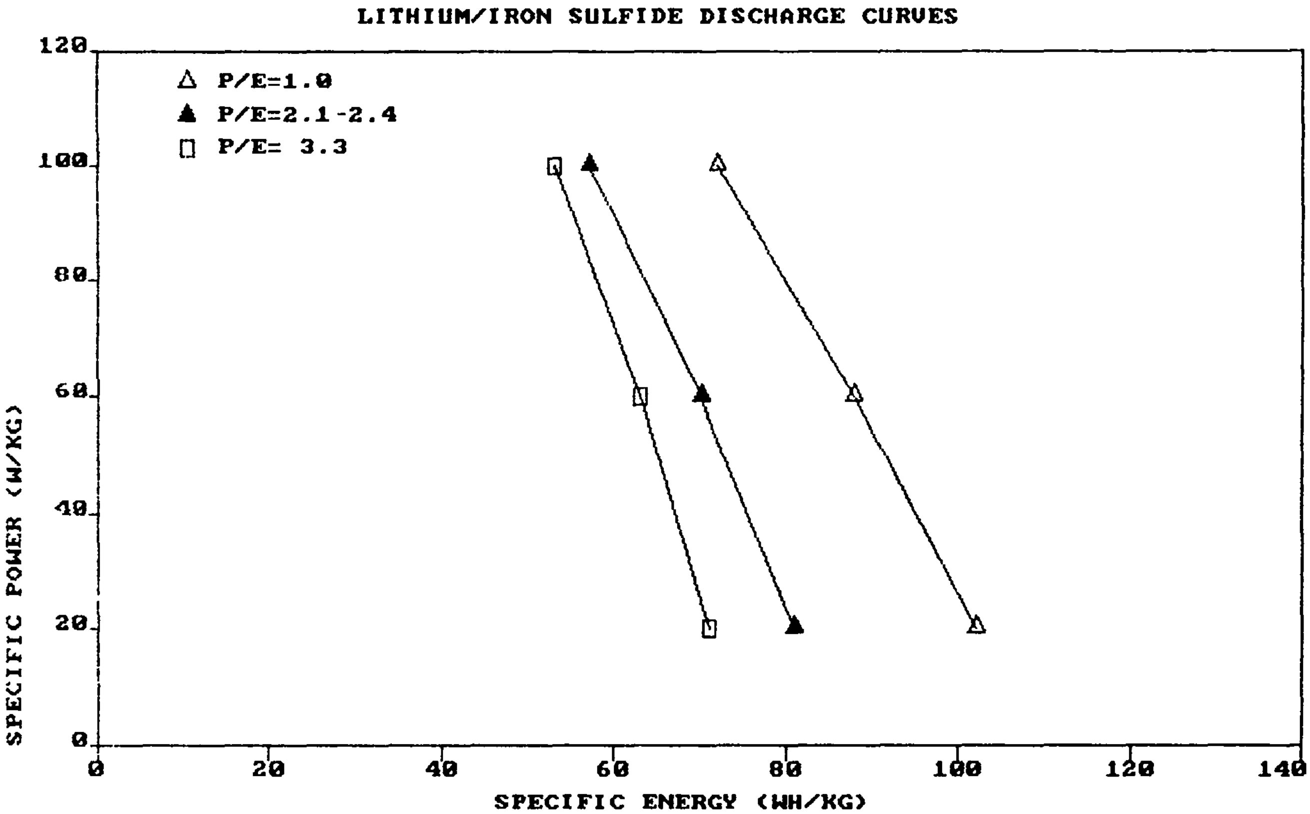

EDA ZINC/CHLORINE POWER VS. DEPTH-OF-DISCHARGE
P/E=1.0
P/E=2.1
P/E=2.4
P/E=3.3
SPECIFIC POWER (W/KG)
DEPTH-OF-DISCHARGE (%)
0
50
100
150
200
250
0
20
40
60
80
100

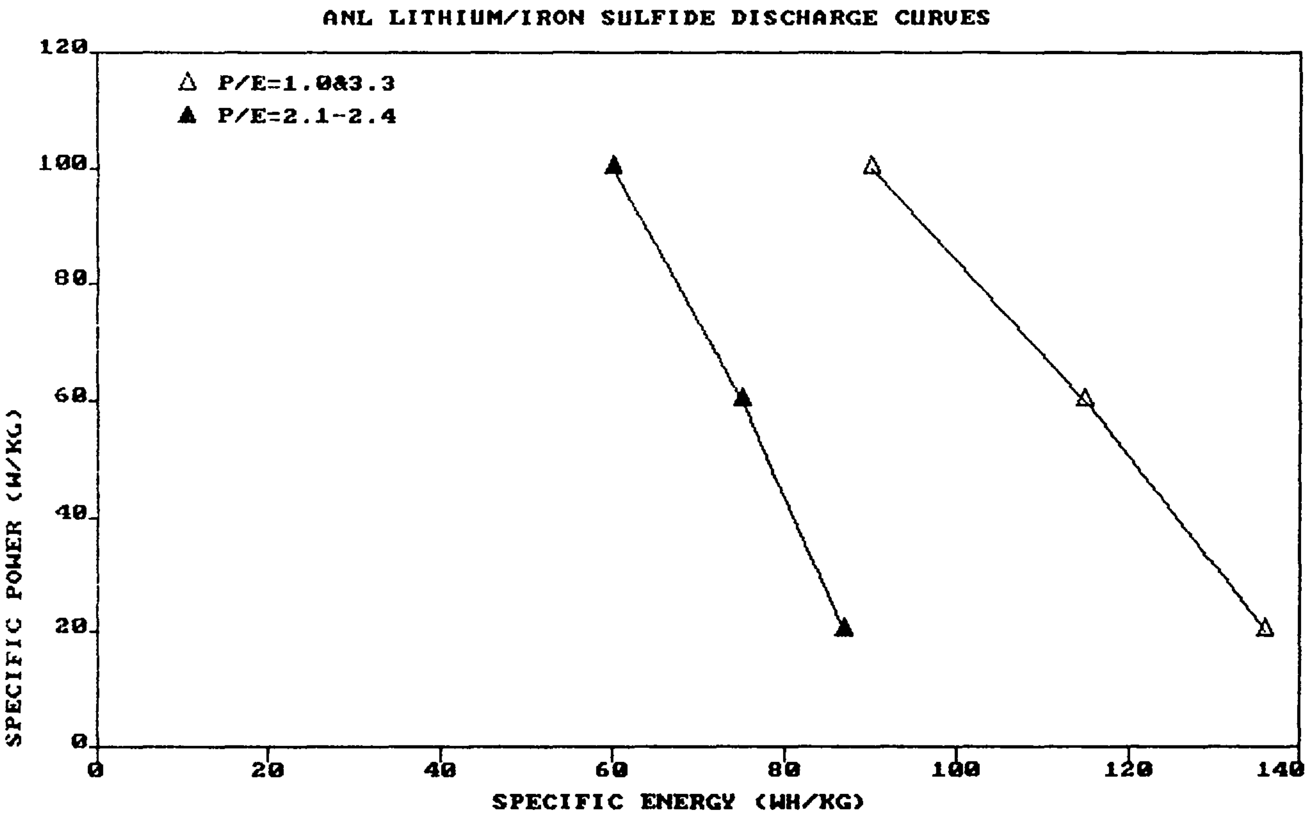

IRON/AIR DISCHARGE CURVES
P/E=1.0
P/E=2.1
P/E=2.4
P/E=3.3
SPECIFIC POWER (W/KG)
SPECIFIC ENERGY (WH/KG)
0
20
40
60
80
100
120
25
50
75
100
125
150
175
200

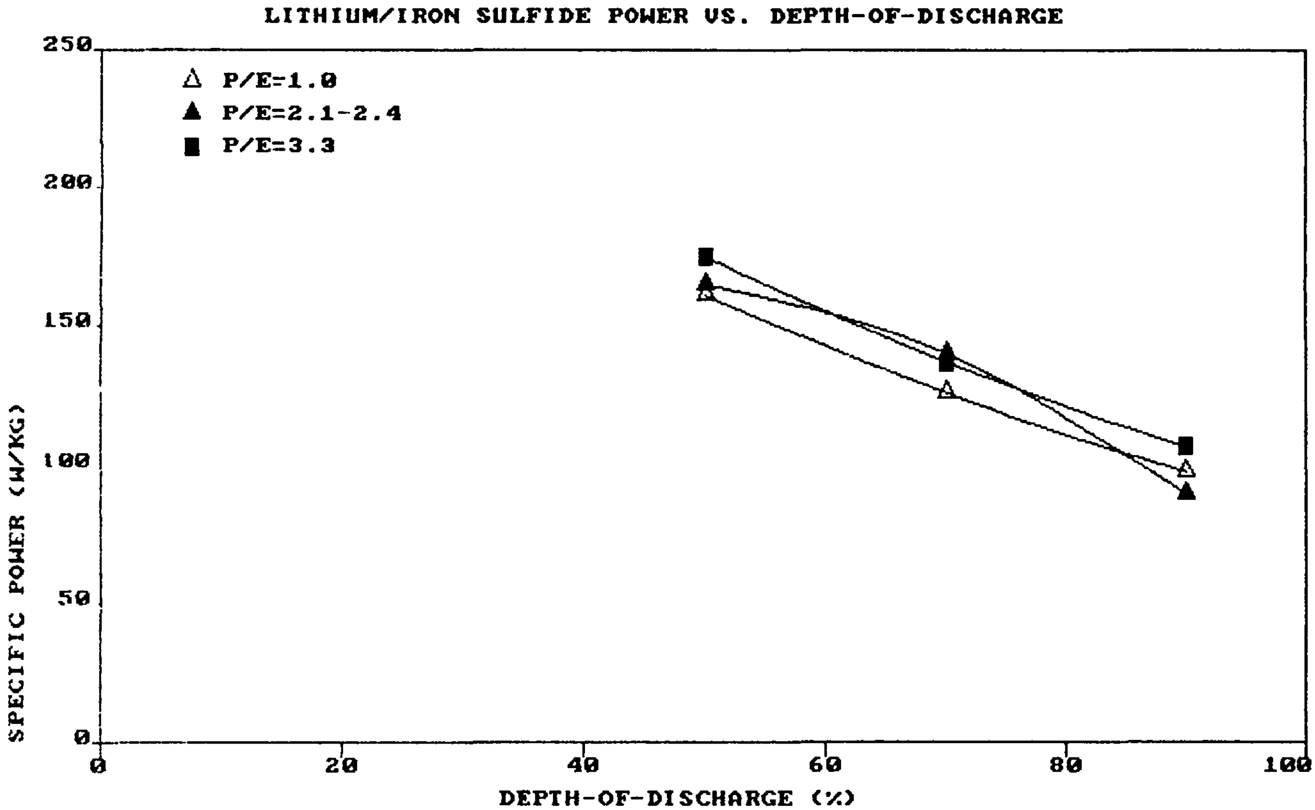

WESTINGHOUSE IRON/AIR DISCHARGE CURVES
P/E=1.0
P/E=2.1
P/E=2.4
P/E=3.3
SPECIFIC POWER (W/KG)
SPECIFIC ENERGY (WH/KG)
0
20
40
60
80
100
120
25
50
75
100
125
150
175
200


IRON/AIR POWER VS. DEPTH-OF-DISCHARGE
P/E=1.0
P/E=2.1
P/F=2.4
P/E=3.3
SPECIFIC POWER (W/KG)
250
200
150
100
50
0
0
20
40
60
80
100
DEPTH-OF-DISCHARGE (%)

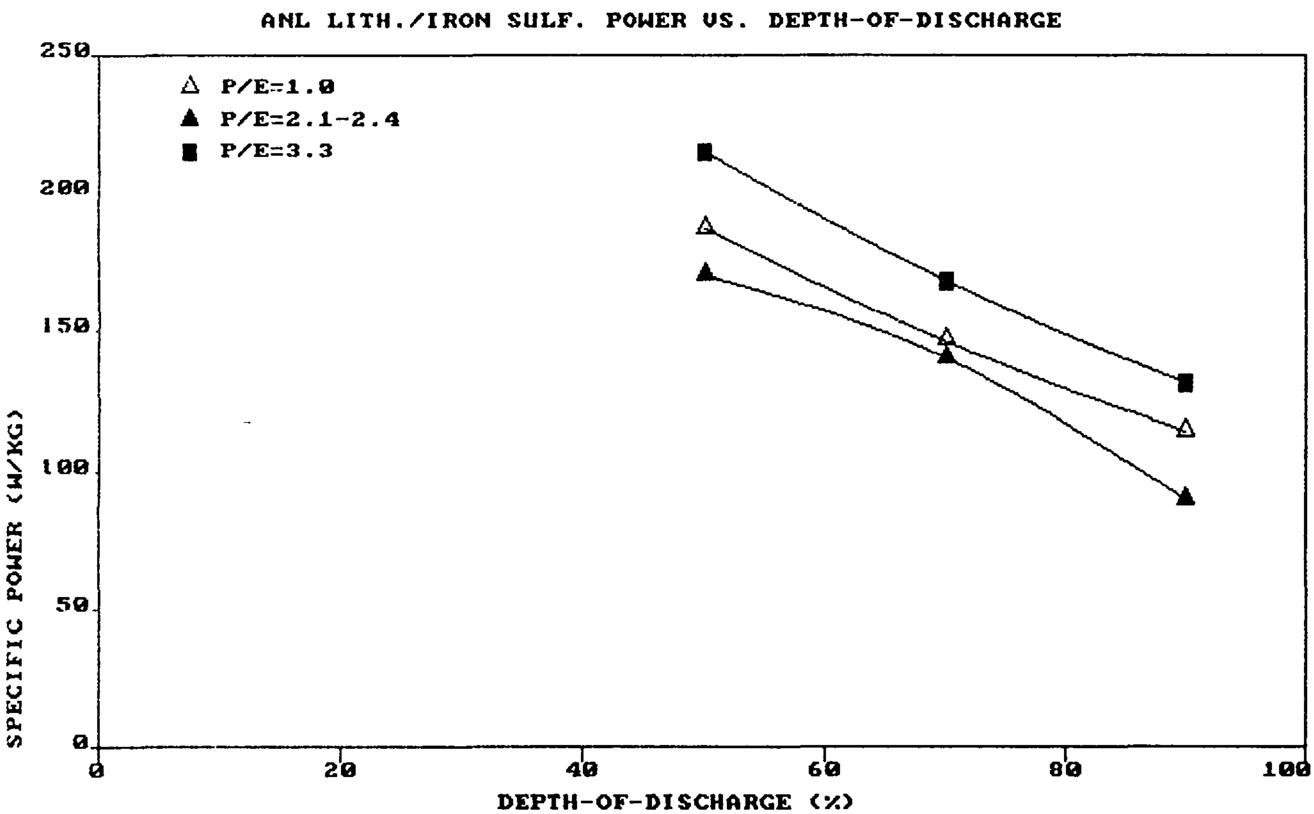

WESTINGHOUSE IRON/AIR POWER VS. DEPTH-OF-DISCHARGE
P/E=1.0
P/E=2.1
P/E=2.4
P/E=3.3
SPECIFIC POWER (W/KG)
350
300
250
200
150
100
50
0
0
20
40
60
80
100
DEPTH-OF-DISCHARGE (%)


LITHIUM/IRON SULFIDE DISCHARGE CURVES
P/E=1.0
P/E=2.1-2.4
P/E= 3.3
SPECIFIC POWER (W/KG)
SPECIFIC ENERGY (WH/KG)
0
20
40
60
80
100
120
140


ANL LITHIUM/IRON SULFIDE DISCHARGE CURVES
P/E=1.0&3.3
P/E=2.1-2.4
SPECIFIC POWER (W/KG)
SPECIFIC ENERGY (WH/KG)
0
20
40
60
80
100
120
140

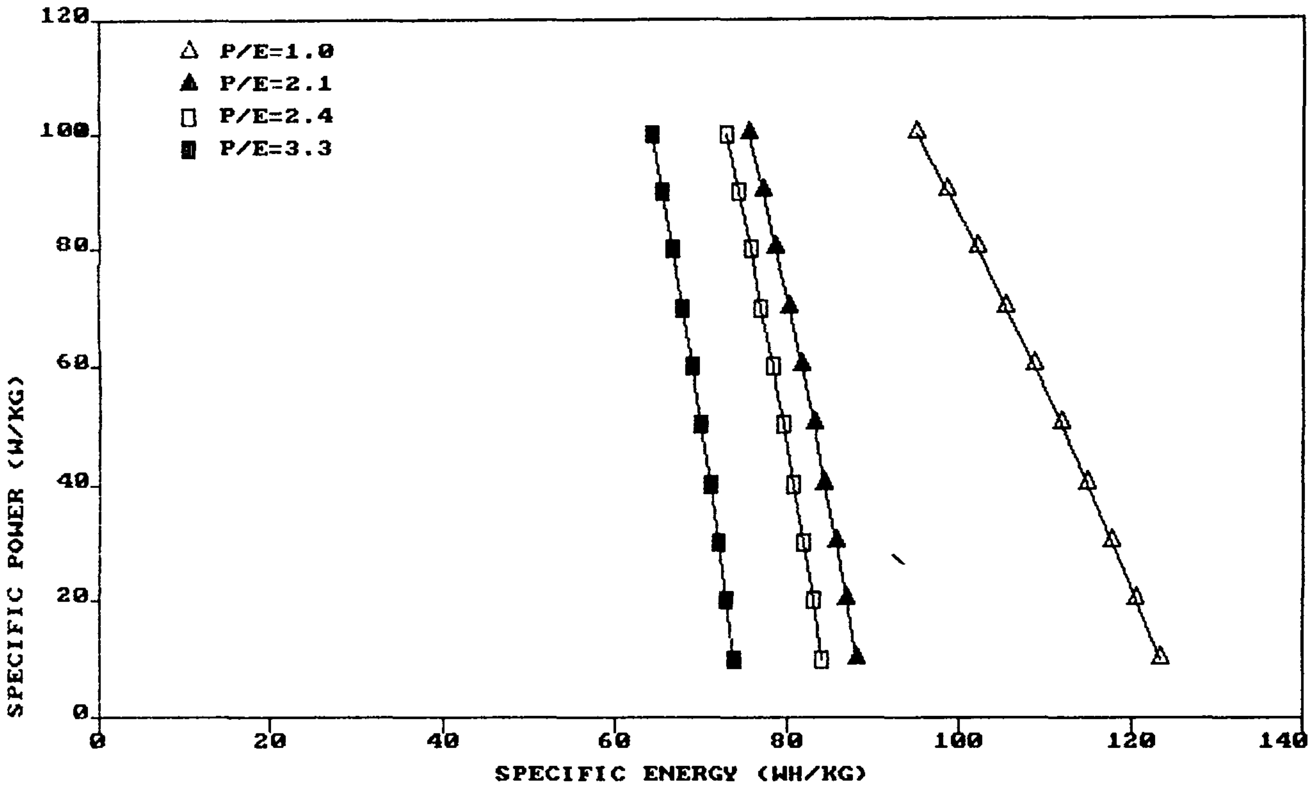


LITHIUM/IRON SULFIDE POWER VS. DEPTH-OF-DISCHARGE
P/E=1.0
P/E=2.1-2.4
P/E=3.3
SPECIFIC POWER (W/KG)
250
200
150
100
50
0
0
20
40
60
80
100
DEPTH-OF-DISCHARGE (%)

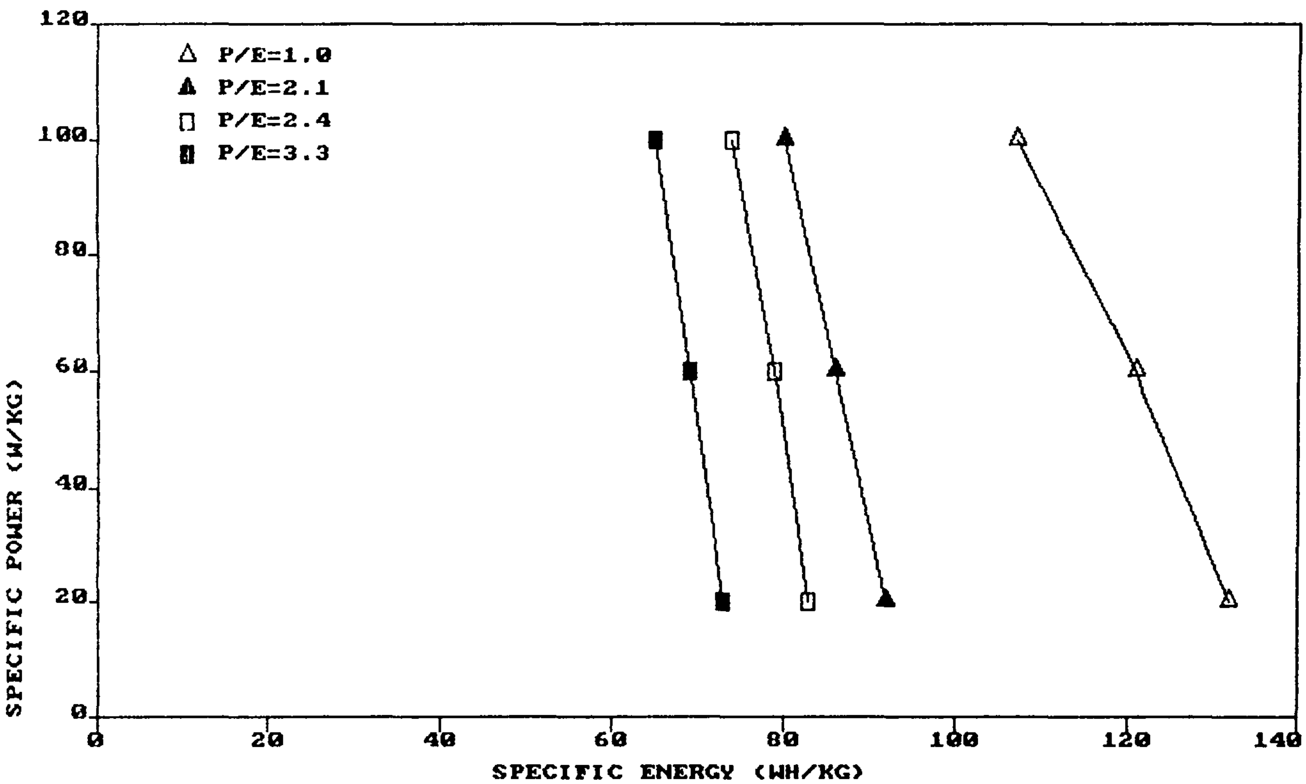


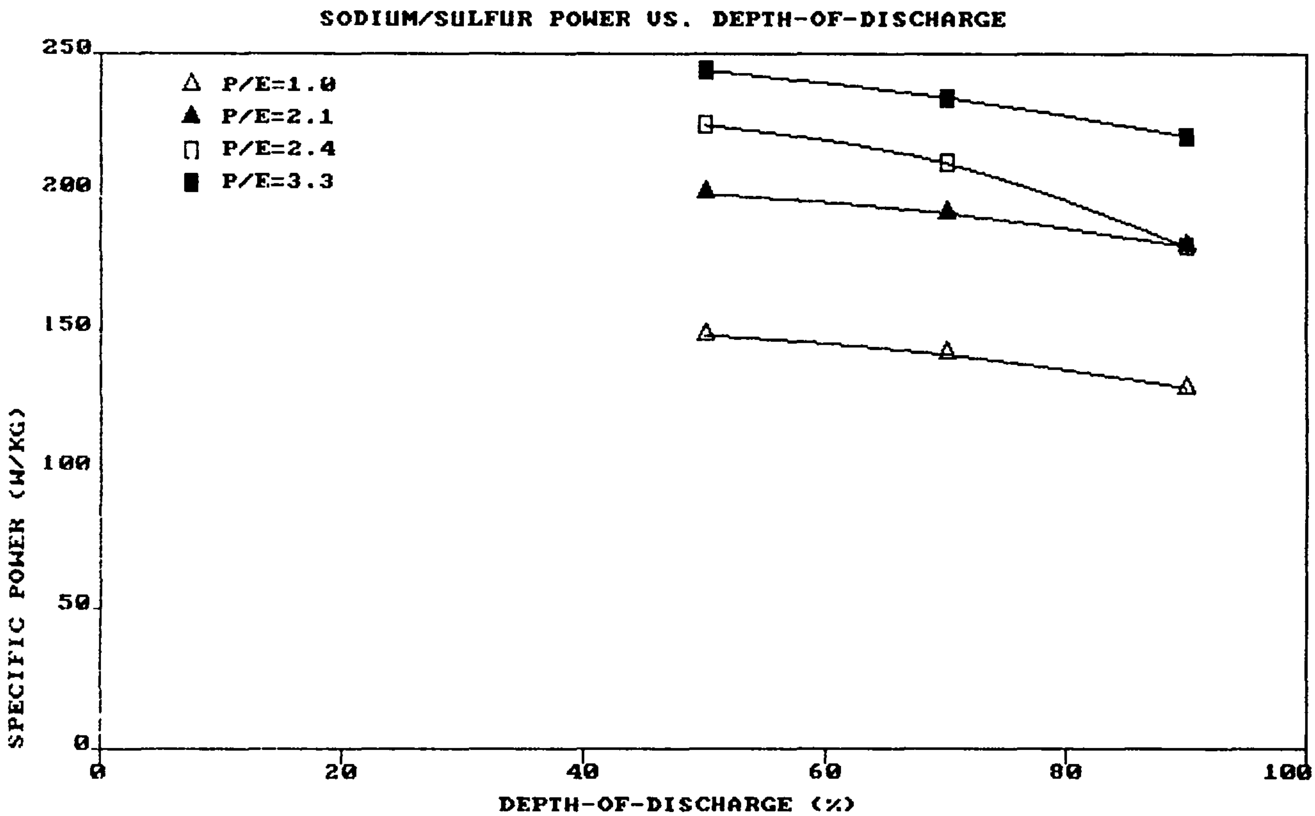
ANL LITH./IRON SULF. POWER VS. DEPTH-OF-DISCHARGE
P/E=1.0
P/E=2.1-2.4
P/E=3.3
SPECIFIC POWER (W/KG)
250
200
150
100
50
0
0
20
40
60
80
100
DEPTH-OF-DISCHARGE (%)

SODIUM/SULFUR DISCHARGE CURVES

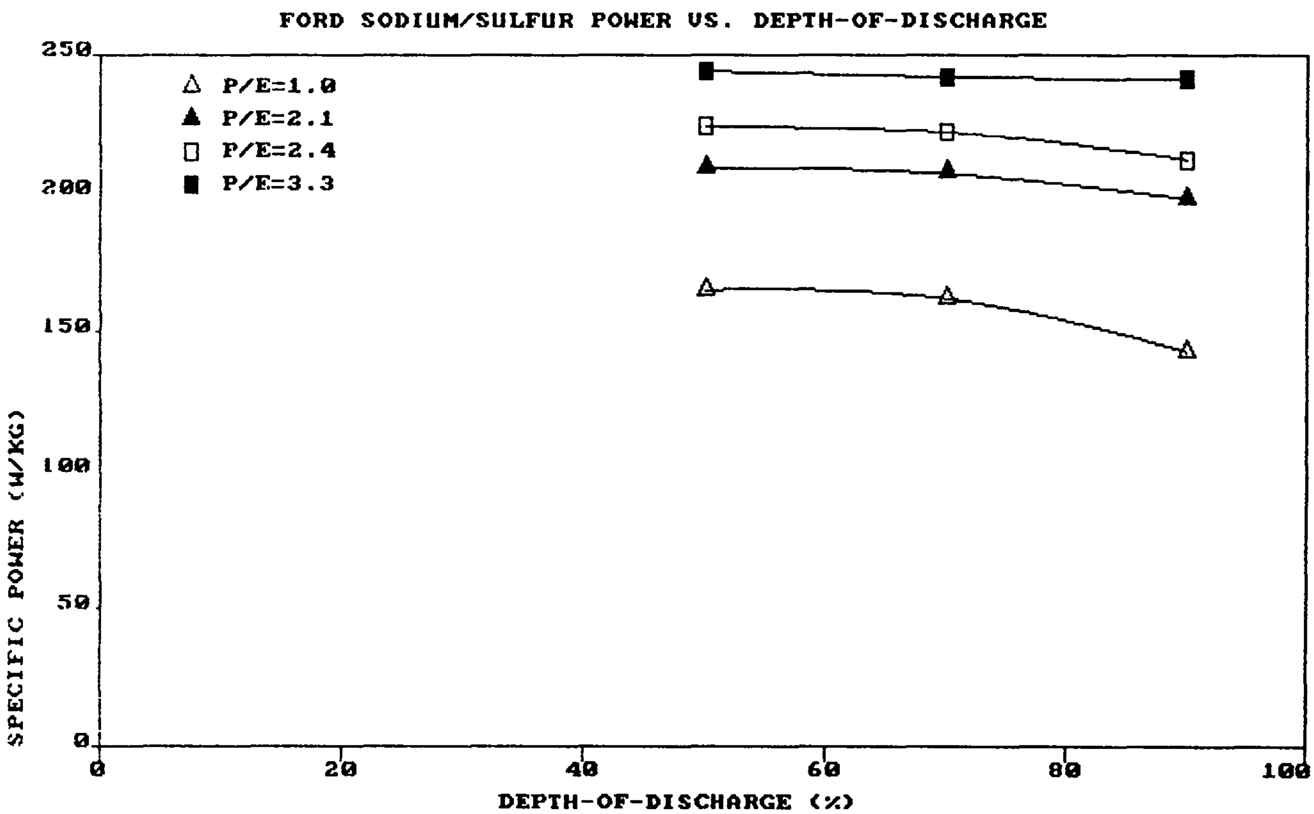


FORD SODIUM/SULFUR DISCHARGE CURVES

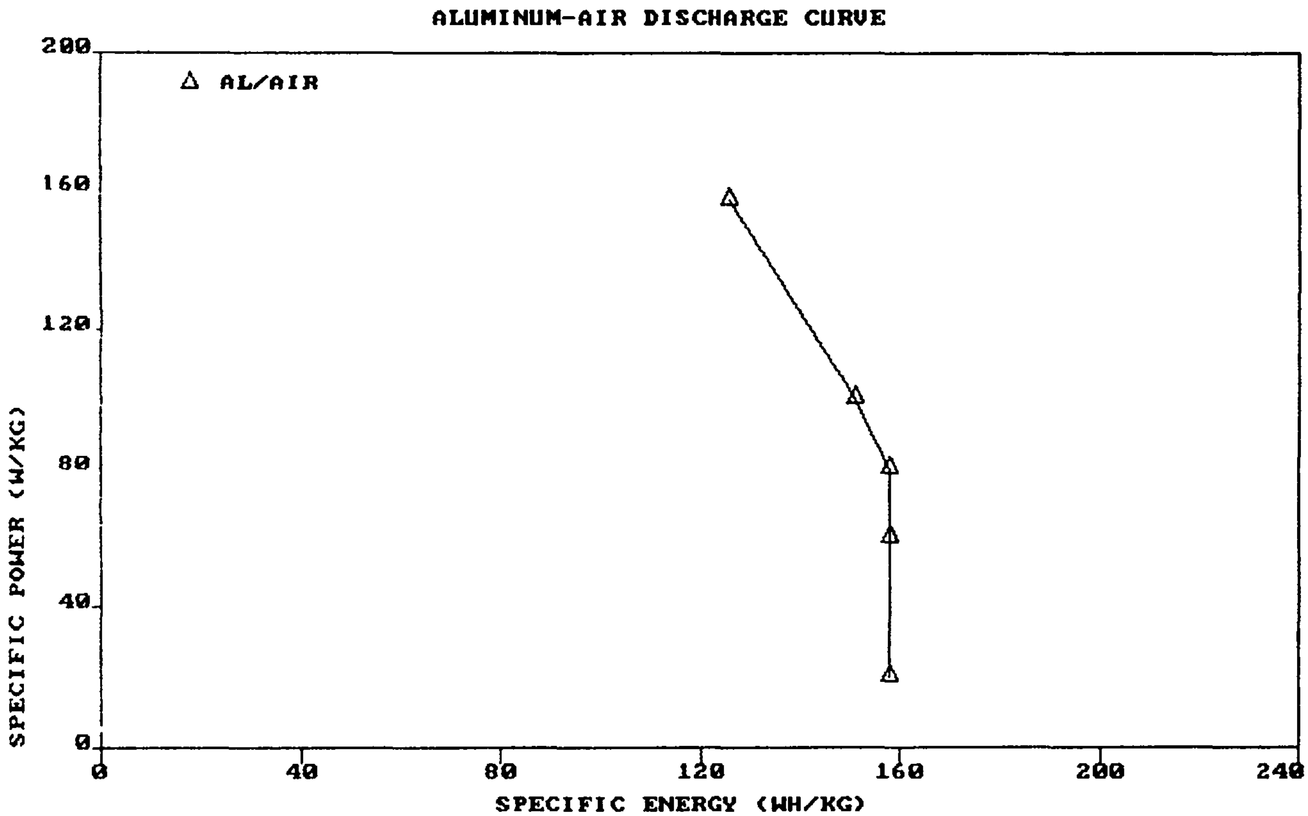


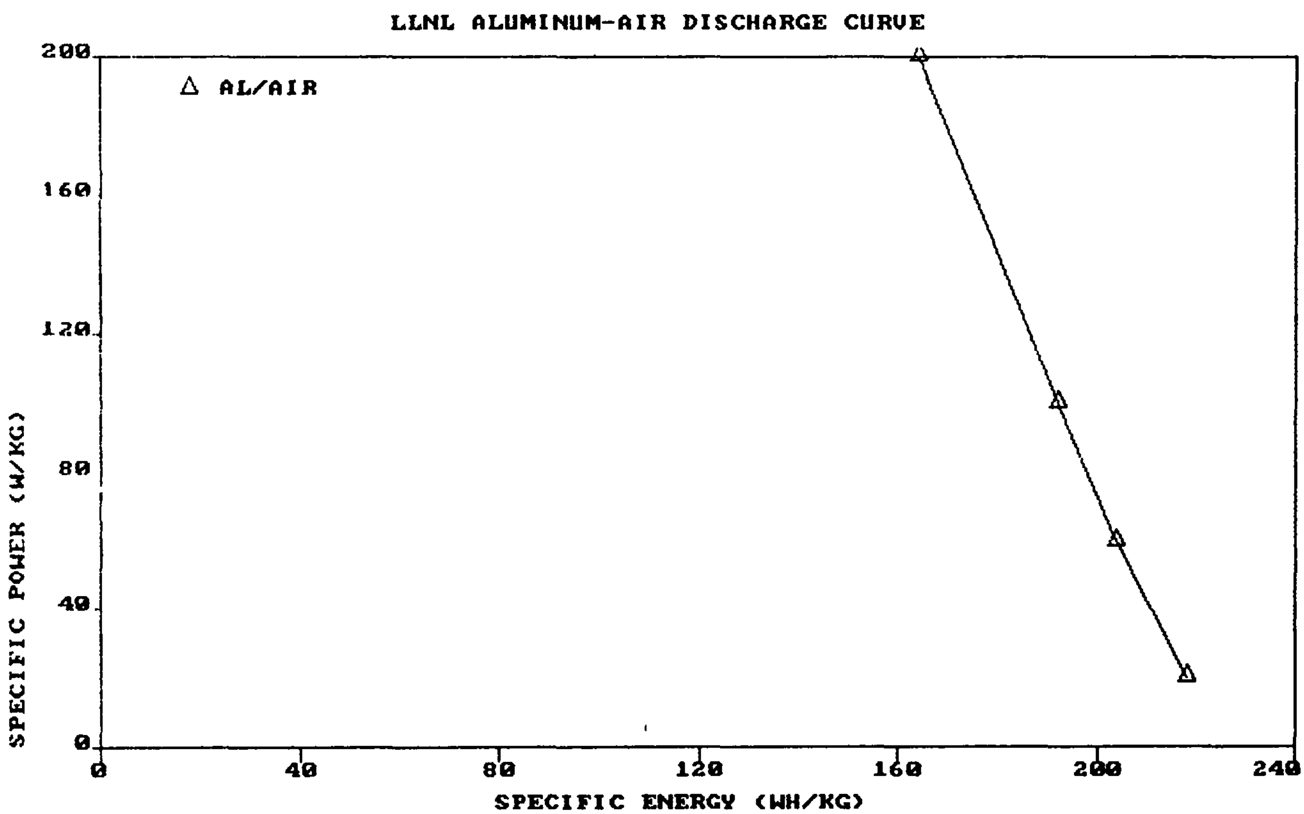


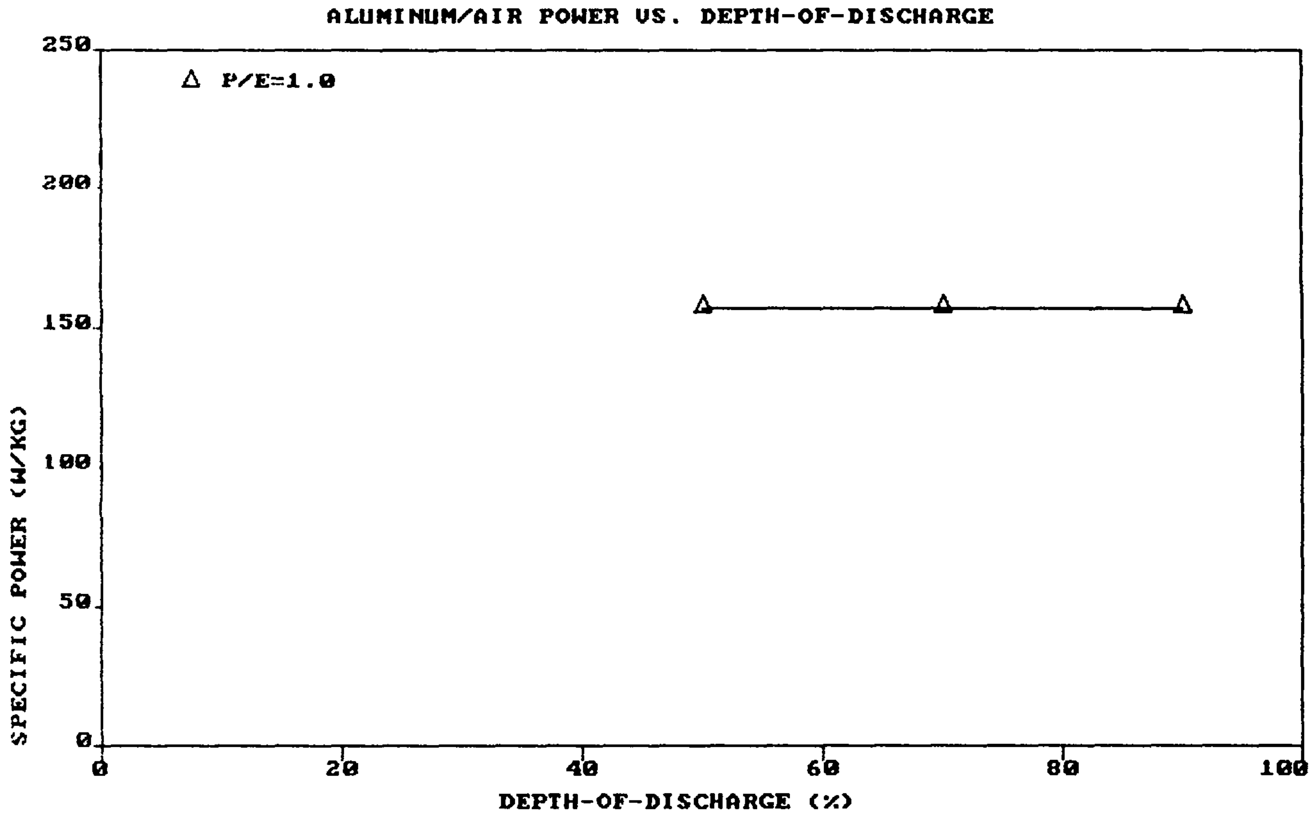
SODIUM/SULFUR POWER VS. DEPTH-OF-DISCHARGE
P/E=1.0
P/E=2.1
P/E=2.4
P/E=3.3
SPECIFIC POWER (W/KG)
DEPTH-OF-DISCHARGE (%)
0
50
100
150
200
250
0
20
40
60
80
100

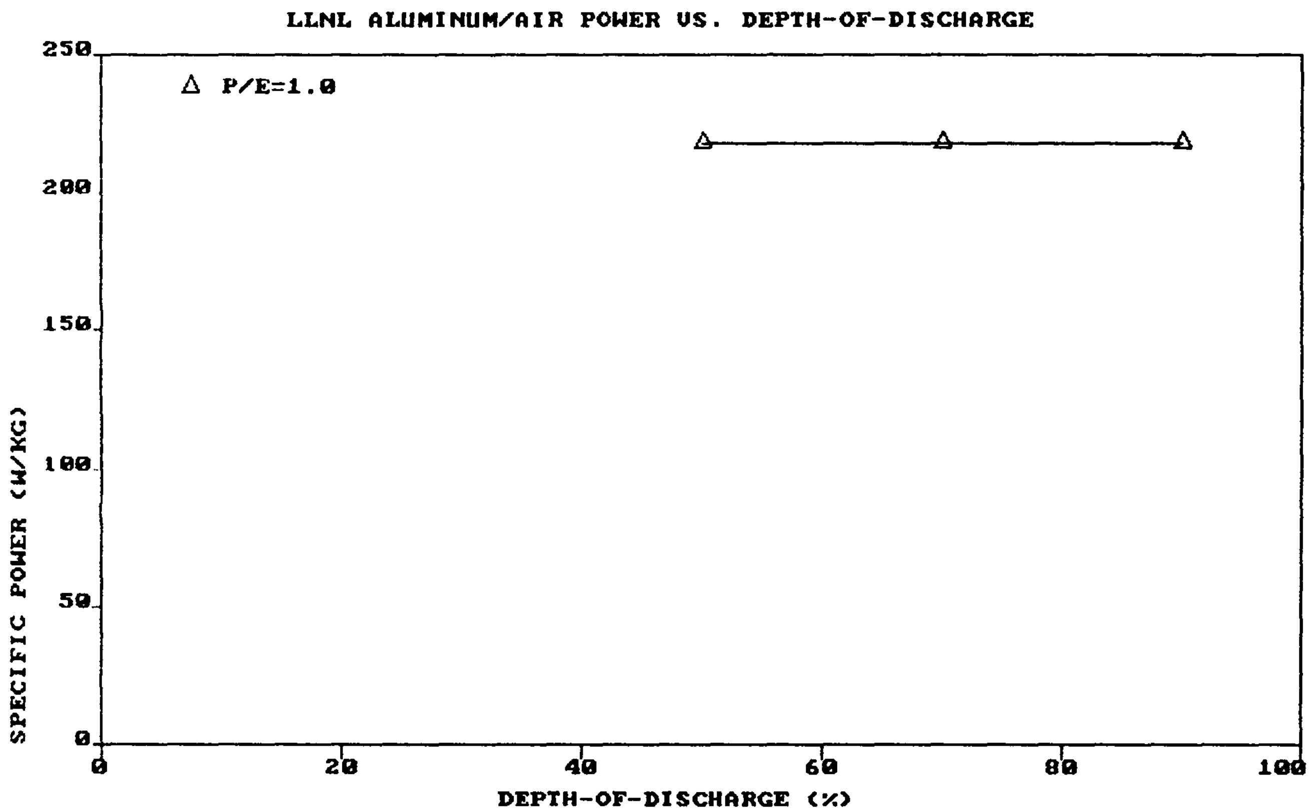


FORD SODIUM/SULFUR POWER VS. DEPTH-OF-DISCHARGE
P/E=1.0
P/E=2.1
P/E=2.4
P/E=3.3
SPECIFIC POWER (W/KG)
DEPTH-OF-DISCHARGE (%)
0
50
100
150
200
250
0
20
40
60
80
100


ALUMINUM-AIR DISCHARGE CURVE
△ AL/AIR
SPECIFIC POWER (W/KG)
SPECIFIC ENERGY (WH/KG)
0
40
80
120
160
200
240


LLNL ALUMINUM-AIR DISCHARGE CURVE
△ AL/AIR
SPECIFIC POWER (W/KG)
SPECIFIC ENERGY (WH/KG)
0
40
80
120
160
200
240


ALUMINUM/AIR POWER VS. DEPTH-OF-DISCHARGE
△ P/E=1.0
SPECIFIC POWER (W/KG)
0
50
100
150
200
250
0
20
40
60
80
100
DEPTH-OF-DISCHARGE (%)


LLNL ALUMINUM/AIR POWER VS. DEPTH-OF-DISCHARGE
△ P/E=1.0
SPECIFIC POWER (W/KG)
0
50
100
150
200
250
0
20
40
60
80
100
DEPTH-OF-DISCHARGE (%)

BATTERY COST FACTORS RELATIVE TO LEAD/ACID

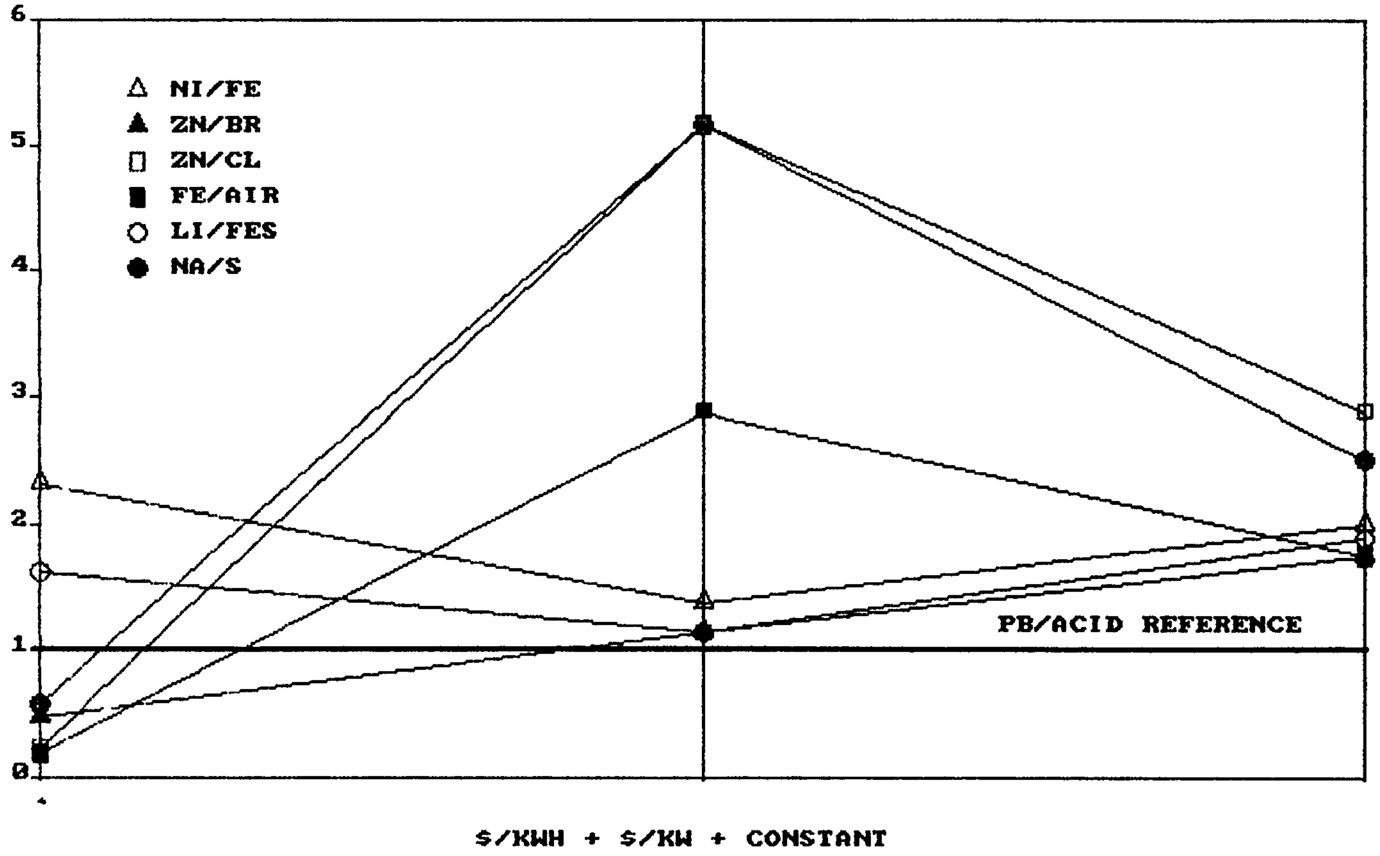


Table D-1. Battery Projections by Review Board

Battery Type	Energy (Wh/kg @20W/kg)	Power (30-s W/kg @10% SOC)	Annual Efficiency (%)	Cycle Life	OEM Cost* a	OEM Cost* b	OEM Cost* c
Pb/Acid	38-45	80-100	75	750	43	9	400
Bip.Pb/Acid	50	275	85	750	80		
Ni/Fe	48-56	75-110	58	1500	100	12	800
Ni/Zn	60	155	70	600	130		
Zn/Br2	40-67	52-94	46	750	20	10	700
Zn/Cl2	42-89	80-115	48	1500	10	45	1150
Fe/Air	52-109	102-146	50	500	8	25	700
Li/FeS	72-102	90-107	60	750	70	10	750
Na/S	73-121	129-220	66	750	25	45	1000
Al/Air	158	157	18**	3000***		42	

* OEM Costs in 1982$ = a*kWh + b*kW + c (Symons equation) , numbers listed are the review board's low estimates

** Source energy

*** Life of air cathode-3000 cold starts, equivalent to 4 years

Table D-2. Battery Projections by Developers

Battery Type	Energy (Wh/kg @20W/kg)	Power (30-s W/kg @10% SOC)	Annual Efficiency (%)	Cycle Life	OEM Cost*
Pb/Acid	38-45	80-100	75	800	$ 53/kWh
Ni/Fe	50-56	100-130	72	1500	130/kWh
Ni/Zn	60	155	70	600	130/kWh
Zn/Br2	40-67	52-94	56	750	40/kWh
Zn/Cl2	50-110	103-154	53	1500	61-81/kW
Fe/Air	98-195	181-309	68	500	21-25/kW
Li/FeS	87-136	90-131	65	1000	99-115/kWh
Na/S	73-132	143-220	75	800**	63-97/kW
Al/Air	218	218	32	3000***	32/kW

* Equivalent values calculated from cost estimates of complete battery systems in some instances

** Surrogate for replacement of 25% of the cells in 1000 cycles

*** Life of air cathode-3000 cold starts, equivalent to 4 years

Table D-3. Specific Performance Projections by Board and Developers[a]: Specific Energy (in Wh/kg) versus Discharge Rate

	Discharge rate, W/kg											
	20				60				100			
Battery	Pas[b]	Com	Van	Hyb	Pas	Com	Van	Hyb	Pas	Com	Van	Hyb
Pb/Acid	45	43	41	38	31	31	31	31	-	18	20	22
Bipolar Pb	50	50	50	50	46	46	46	46	41	41	41	41
Ni/Fe	56 (56)	54 (56)	52 (56)	48 (50)	44 (46)	48 (46)	46 (46)	44 (44)	- (31)	36 (31)	36 (31)	38 (37)
Ni/Zn	60	60	60	60	58	58	58	58	53	53	53	53
Zn/Br_2	67	48	49	40	54	42	44	36	-	32	35	29
Zn/Cl_2	89 (110)	54 (66)	54 (65)	42 (50)	78 (100)	48 (60)	49 (61)	38 (47)	- (85)	38 (55)	41 (56)	31 (44)
Fe/Air	109 (195)	68 (134)	68 (123)	52 (98)	100 (182)	63 (128)	64 (118)	49 (94)	82 (167)	54 (122)	56 (113)	43 (91)
Li/FeS	102 (136)	81 (87)	81 (87)	71 (136)	88 (115)	70 (75)	71 (75)	63 (115)	72 (90)	57 (60)	57 (60)	53 (90)
Na/S	121 (132)	87 (92)	83 (83)	73 (73)	109 (121)	82 (86)	78 (79)	69 (69)	95 (107)	76 (80)	73 (74)	64 (65)
Al/Air[c]	158 (218)	-	-	-	158 (204)	-	-	-	151 (192)	-	-	-

[a]Developers' projections are in parentheses.

[b]The applications are associated with specific power-to-energy ratio design targets as follows: "Pas" (full-performance) P/E = 1.0 (50 kw/50 kWh), "Com" (commuter) P/E = 2.1 (25 kw/12 kWh), "Van" (commercial van) P/E = 2.4 (60 kW/25 kWh), "Hyb" (hybrid) P/E - 3.3 (50 kW/15 kWh).

[c]"Advanced" system.

Table D-4. Specific Performance Projections by Board and Developers[a]: Specific Power (in W/kg) versus State of Charge

	State of Charge, %											
	50				30				10			
Battery	Pas[b]	Com	Van	Hyb	Pas	Com	Van	Hyb	Pas	Com	Van	Hyb
Pb/Acid	120	135	135	145	105	115	115	125	80	90	90	100
Bipolar Pb	400	400	400	400	345	345	345	345	275	275	275	275
Ni/Fe	120 (160)	141 (160)	141 (160)	160 (190)	105 (140)	120 (140)	120 (140)	140 (170)	75 (100)	90 (100)	90 (100)	110 (130)
Ni/Zn	204	204	204	204	185	185	185	185	155	155	155	155
Zn/Br_2	83	115	135	150	69	96	113	125	52	72	85	94
Zn/Cl_2	86 (105)	110 (130)	127 (147)	130 (158)	84 (104)	103 (128)	121 (145)	128 (156)	80 (103)	90 (127)	110 (144)	115 (154)
Fe/Air	110 (181)	140 (262)	157 (277)	165 (309)	107 (181)	131 (262)	150 (277)	162 (309)	102 (181)	115 (262)	136 (277)	146 (309)
Li/Fes	161 (187)	165 (170)	165 (170)	175 (215)	126 (146)	140 (140)	140 (140)	137 (168)	98 (114)	90 (90)	90 (90)	107 (131)
Na/S	148 (165)	199 (209)	224 (224)	244 (244)	141 (162)	192 (207)	210 (222)	234 (242)	129 (143)	180 (198)	180 (212)	220 (241)
Al/Air[c]	157 (218)	-	-	-	157 (218)	-	-	-	157 (218)	-	-	-

[a]Developers' projections are in parentheses.

[b]The applications are associated with specific power-to-energy ratio design targets as follows· "Pas" (full-performance) P/E = 1.0 (50 kw/50 kWh), "Com" (commuter) P/E = 2.1 (25 kw/12 kWh), "Van" (commercial van) P/E = 2.4 (60 kW/25 kWh), "Hyb" (hybrid) P/E - 3.3 (50 kW/15 kWh).

[c]"Advanced" system.

APPENDIX E

VEHICLE COST SHEETS
BATTERY DEVELOPER PROJECTIONS

ELECTRIC AND HYBRID VEHICLE COST MODEL

PB/ACID VAN - $80/KWH 09-12-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: VAN
CURB WEIGHT: 1735 KG
VEHICLE WEIGHT , WT: 2030
LIFE: 128480 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 453 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .3188406

NAME: PBAC/AD2.4
BATTERY CYCLE LIFE: 800
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 37.1 KW
CONTROLLER: 41.2 KW

TYPE: ac

DRIVING --
ANNUAL ELEC USE: 3075.49 KW-H

AMOUNT: 12848 KM/YEAR

-- OUTPUTS --

COST ITEMS-

		$	C/KM		$	C/KM
BASIC VEHICLE COST		8267.50	6.435			
MOTOR COST		704.90	0.549			
CONTROLLER COST		1854.00	1.443			
EV TRANSMISSION COST		191.58	0.149			
BATTERY	LOW	1342.32	1.045	HIGH	1610.79	1.254
INITIAL COST	LOW	12360.30	9.620	HIGH	12628.77	9.829
DOWNPAYMENT	LOW	2472.06	1.924	HIGH	2525.75	1.966
REPLACEM'T BATTS	LOW	1342.32	1.045	HIGH	1610.79	1.254
REPAIRS & MAINTENANCE		2281.97	1.776			
REPLACEMENT TIRES		339.85	0.265			
INSURANCE		3479.00	2.708			
GARAGING,PARK, TOLL		782.50	0.609			
TITLE, REG, LIC,	LOW.	818.02	0.637	HIGH	831.44	0.647
ELECTRICITY		1537.75	1.197			
PRIN & INT	LOW	9888.24	7.696	HIGH	10103.01	7.863
OPERATING COST	LOW	20469.64	15.932	HIGH	20697.84	16.110
VEHICLE SALVAGE VALUE	LOW	668.57	0.520	HIGH	717.33	0.558
BATTERY SALVAGE	LOW	30.83	0.024	HIGH	30.83	0.024
TOTAL LIFE CYCLE COST	LOW	22242.30	17.312	HIGH	22475.43	17.493

ELECTRIC AND HYBRID VEHICLE COST MODEL

NI/FE VAN - EPI PROJECTIONS 09-12-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: VAN
CURB WEIGHT: 1588 KG
VEHICLE WEIGHT , WT: 1883
LIFE: 128480 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 348 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .299364

NAME: NI-FE2.4
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.25

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 34.4 KW
CONTROLLER: 38.2 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 3082.095 KW-H

AMOUNT: 12848 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM		$	C/KM
BASIC VEHICLE COST	8036.92	6.255			
MOTOR COST	653.60	0.509			
CONTROLLER COST	1719.00	1.338			
EV TRANSMISSION COST	177.63	0.138			
BATTERY LOW	3454.69	2.689	HIGH	0.00	0.000
INITIAL COST LOW	14041.84	10.929	HIGH	10587.15	8.240
DOWNPAYMENT LOW	2808.37	2.186	HIGH	2117.43	1.648
REPLACEM'T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	2648.14	2.061			
REPLACEMENT TIRES	326.61	0.254			
INSURANCE	3479.00	2.708			
GARAGING, PARK, TOLL	782.50	0.609			
TITLE, REG, LIC, LOW.	902.09	0.702	HIGH	729.36	0.568
ELECTRICITY	1541.05	1.199			
PRIN & INT LOW	11233.47	8.743	HIGH	8469.72	6.592
OPERATING COST LOW	20912.86	16.277	HIGH	17976.37	13.992
VEHICLE SALVAGE VALUE LOW	408.18	0.318	HIGH	408.18	0.318
BATTERY SALVAGE LOW	127.84	0.100	HIGH	127.84	0.100
TOTAL LIFE CYCLE COST LOW	23185.21	18.046	HIGH	19557.78	15.222

ELECTRIC AND HYBRID VEHICLE COST MODEL

ZN/BR VAN - $60/KWH 09-12-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: VAN
CURB WEIGHT: 1722 KG
VEHICLE WEIGHT , WT: 2017
LIFE: 128480 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 444 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .3097282

NAME: ZN-BR2/2.4
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 36.9 KW
CONTROLLER: 41 KW

TYPE: ac

DRIVING --
ANNUAL ELEC USE: 5172.415 KW-H

AMOUNT: 12848 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM		
BASIC VEHICLE COST	8244.07	6.417		
MOTOR COST	701.10	0.546		
CONTROLLER COST	1845.00	1.436		
EV TRANSMISSION COST	190.65	0.148		
BATTERY LOW	1186.69	0.924	HIGH 2041.11	1.589
INITIAL COST LOW	12167.51	9.470	HIGH13021.93	10.135
DOWNPAYMENT LOW	2433.50	1.894	HIGH 2604.39	2.027
REPLACEM'T BATTS LOW	1186.69	0.924	HIGH 2041.11	1.589
REPAIRS & MAINTENANCE	3746.64	2.916		
REPLACEMENT TIRES	338.67	0.264		
INSURANCE	3479.00	2.708		
GARAGING,PARK, TOLL	782.50	0.609		
TITLE, REG, LIC, LOW.	808.38	0.629	HIGH 851.10	0.662
ELECTRICITY	2586.21	2.013		
PRIN & INT LOW	9734.01	7.576	HIGH10417.55	8.108
OPERATING COST LOW	22662.10	17.639	HIGH23388.36	18.204
VEHICLE SALVAGE VALUE LOW	560.80	0.436	HIGH 659.76	0.514
BATTERY SALVAGE LOW	43.51	0.034	HIGH 43.51	0.034
TOTAL LIFE CYCLE COST LOW	24491.29	19.062	HIGH25289.48	19.684

ELECTRIC AND HYBRID VEHICLE COST MODEL

ZN/CL VAN EDA PROJECTIONS 09-12-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: VAN
CURB WEIGHT: 1477 KG
VEHICLE WEIGHT , WT: 1772
LIFE: 128480 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 270 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .299364

NAME: ZN-CL2/2.4
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 32.4 KW
CONTROLLER: 36 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 4290.79 KW-H

AMOUNT: 12848 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM		$	C/KM
BASIC VEHICLE COST	7852.82	6.112			
MOTOR COST	615.60	0.479			
CONTROLLER COST	1620.00	1.261			
EV TRANSMISSION COST	167.40	0.130			
BATTERY LOW	3234.11	2.517	HIGH	0.00	0.000
INITIAL COST LOW	13489.93	10.500	HIGH	10255.82	7.982
DOWNPAYMENT LOW	2697.99	2.100	HIGH	2051.16	1.596
REPLACEM'T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	3746.64	2.916			
REPLACEMENT TIRES	316.61	0.246			
INSURANCE	3479.00	2.708			
GARAGING,PARK, TOLL	782.50	0.609			
TITLE, REG, LIC, LOW.	874.50	0.681	HIGH	712.79	0.555
ELECTRICITY	2145.40	1.670			
PRIN & INT LOW	10791.94	8.400	HIGH	8204.66	6.386
OPERATING COST LOW	22136.59	17.230	HIGH	19387.60	15.090
VEHICLE SALVAGE VALUE LOW	395.41	0.308	HIGH	395.41	0.308
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	24439.17	19.022	HIGH	21043.36	16.379

ELECTRIC AND HYBRID VEHICLE COST MODEL

FE/AIR VAN - WESTINGHOUSE PROJECTIONS 09-12-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: VAN
CURB WEIGHT: 1282 KG
VEHICLE WEIGHT , WT: 1577
LIFE: 128480 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 131 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .3165972

NAME: FE-AIR2.4
BATTERY CYCLE LIFE: 500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 28.8 KW
CONTROLLER: 32 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 3025.225 KW-H

AMOUNT: 12848 KM/YEAR

-- OUTPUTS --

COST ITEMS-

		$	C/KM		$	C/KM
BASIC VEHICLE COST		7545.38	5.873			
MOTOR COST		547.20	0.426			
CONTROLLER COST		1440.00	1.121			
EV TRANSMISSION COST		148.80	0.116			
BATTERY	LOW	1039.13	0.809	HIGH	0.00	0.000
		-------	------			
INITIAL COST	LOW	10720.51	8.344	HIGH	9681.38	7.535
DOWNPAYMENT	LOW	2144.10	1.669	HIGH	1936.28	1.507
REPLACEM'T BATTS	LOW	2078.26	1.618	HIGH	0.00	0.000
REPAIRS & MAINTENANCE		3746.64	2.916			
REPLACEMENT TIRES		299.05	0.233			
INSURANCE		3479.00	2.708			
GARAGING,PARK, TOLL		782.50	0.609			
TITLE, REG, LIC,	LOW.	736.03	0.573	HIGH	684.07	0.532
ELECTRICITY		1512.61	1.177			
PRIN & INT	LOW	8576.41	6.675	HIGH	7745.10	6.028
		-------	------			
OPERATING COST	LOW	21210.49	16.509	HIGH	20327.24	15.821
VEHICLE SALVAGE VALUE	LOW	488.65	0.380	HIGH	373.26	0.291
BATTERY SALVAGE	LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST	LOW	22865.94	17.797	HIGH	21890.25	17.038

ELECTRIC AND HYBRID VEHICLE COST MODEL

LI/FES VAN - ANL PROJECTIONS 09-12-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: VAN
CURB WEIGHT: 1464 KG
VEHICLE WEIGHT , WT: 1759
LIFE: 128480 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 260 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2417583

NAME: LI-FE-S2.4
BATTERY CYCLE LIFE: 1000
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.25

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 32.1 KW
CONTROLLER: 35.7 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 3236.09 KW-H

AMOUNT: 12848 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	7838.53	6.101			
MOTOR COST	609.90	0.475			
CONTROLLER COST	1606.50	1.250			
EV TRANSMISSION COST	166.01	0.129			
BATTERY LOW	3053.70	2.377	HIGH	0.00	0.000
INITIAL COST LOW	13274.63	10.332	HIGH	10220.93	7.955
DOWNPAYMENT LOW	2654.93	2.066	HIGH	2044.19	1.591
REPLACEM'T BATTS LOW	3053.70	2.377	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	2648.14	2.061			
REPLACEMENT TIRES	315.44	0.246			
INSURANCE	3479.00	2.708			
GARAGING, PARK, TOLL	782.50	0.609			
TITLE, REG, LIC, LOW.	863.73	0.672	HIGH	711.05	0.553
ELECTRICITY	1618.04	1.259			
PRIN & INT LOW	10619.71	8.266	HIGH	8176.75	6.364
OPERATING COST LOW	23380.27	18.198	HIGH	20784.62	16.177
VEHICLE SALVAGE VALUE LOW	3133.16	2.439	HIGH	394.06	0.307
BATTERY SALVAGE LOW	45.24	0.035	HIGH	45.24	0.035
TOTAL LIFE CYCLE COST LOW	22856.79	17.790	HIGH	22389.50	17.426

ELECTRIC AND HYBRID VEHICLE COST MODEL

NA/S VAN - FORD PROJECTIONS 09-12-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: VAN
CURB WEIGHT: 1353 KG
VEHICLE WEIGHT , WT: 1648
LIFE: 128480 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 181 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .3235294

NAME: NA-S2.4
BATTERY CYCLE LIFE: 800
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.75

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 30.1 KW
CONTROLLER: 33.4 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 2593.69 KW-H

AMOUNT: 12848 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM		$	C/KM
BASIC VEHICLE COST	7662.15	5.964			
MOTOR COST	571.90	0.445			
CONTROLLER COST	1503.00	1.170			
EV TRANSMISSION COST	155.31	0.121			
BATTERY LOW	3296.50	2.566	HIGH	0.00	0.000
INITIAL COST LOW	13188.86	10.265	HIGH	9892.36	7.700
DOWNPAYMENT LOW	2637.77	2.053	HIGH	1978.47	1.540
REPLACEM'T BATTS LOW	3296.50	2.566	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	3380.48	2.631			
REPLACEMENT TIRES	305.44	0.238			
INSURANCE	3479.00	2.708			
GARAGING,PARK, TOLL	782.50	0.609			
TITLE, REG, LIC, LOW.	859.44	0.669	HIGH	694.62	0.541
ELECTRICITY	1296.84	1.009			
PRIN & INT LOW	10551.09	8.212	HIGH	7913.89	6.160
OPERATING COST LOW	23951.30	18.642	HIGH	21149.27	16.461
VEHICLE SALVAGE VALUE LOW	891.93	0.694	HIGH	381.39	0.297
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	25697.15	20.001	HIGH	22746.35	17.704

ELECTRIC AND HYBRID VEHICLE COST MODEL

PB/ACID 2-P EV - 80/KWH 09-12-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 2-PASS
CURB WEIGHT: 933 KG
VEHICLE WEIGHT , WT: 1069
LIFE: 118861.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 306 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2278544

NAME: PBAC/AD2.1
BATTERY CYCLE LIFE: 800
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1

TRANSMISSION TYPE: fixed ratio

MOTOR --
RATED POWER: 16.8 KW
CONTROLLER: 27.7 KW

TYPE: ac

DRIVING --
ANNUAL ELEC USE: 1531.046 KW-H

AMOUNT: 11886.19 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	4106.78	3.455			
MOTOR COST	319.20	0.269			
CONTROLLER COST	1246.50	1.049			
EV TRANSMISSION COST	128.81	0.108			
BATTERY LOW	950.96	0.800	HIGH	1283.80	1.080
	-------	------			
INITIAL COST LOW	6752.25	5.681	HIGH	7085.09	5.961
DOWNPAYMENT LOW	1350.45	1.136	HIGH	1417.02	1.192
REPLACEM'T BATTS LOW	950.96	0.800	HIGH	1283.80	1.080
REPAIRS & MAINTENANCE	2172.33	1.828			
REPLACEMENT TIRES	227.47	0.191			
INSURANCE	3479.00	2.927			
GARAGING,PARK, TOLL	782.50	0.658			
TITLE, REG, LIC, LOW.	537.61	0.452	HIGH	554.25	0.466
ELECTRICITY	765.52	0.644			
PRIN & INT LOW	5401.80	4.545	HIGH	5668.07	4.769
	-------	------			
OPERATING COST LOW	14317.20	12.045	HIGH	14600.11	12.283
VEHICLE SALVAGE VALUE LOW	889.83	0.749	HIGH	1122.99	0.945
BATTERY SALVAGE LOW	21.84	0.018	HIGH	21.84	0.018
TOTAL LIFE CYCLE COST LOW	14755.98	12.414	HIGH	14872.30	12.512

ELECTRIC AND HYBRID VEHICLE COST MODEL

80-MI NI/FE 2-P EV - EPI PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 2-PASS
CURB WEIGHT: 828 KG
VEHICLE WEIGHT , WT: 964
LIFE: 118861.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 231 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2229545

NAME: NI-FE2.1
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.25

TRANSMISSION TYPE: fixed ratio

MOTOR --
RATED POWER: 15.2 KW
CONTROLLER: 25 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 1534.617 KW-H

AMOUNT: 11886.19 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	3941.70	3.316			
MOTOR COST	288.80	0.243			
CONTROLLER COST	1125.00	0.946			
EV TRANSMISSION COST	116.25	0.098			
BATTERY LOW	2293.20	1.929	HIGH	0.00	0.000
INITIAL COST LOW	7764.95	6.533	HIGH	5471.75	4.603
DOWNPAYMENT LOW	1552.99	1.307	HIGH	1094.35	0.921
REPLACEM'T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	2511.08	2.113			
REPLACEMENT TIRES	219.43	0.185			
INSURANCE	3479.00	2.927			
GARAGING,PARK, TOLL	782.50	0.658			
TITLE, REG, LIC, LOW.	588.25	0.495	HIGH	473.59	0.398
ELECTRICITY	767.31	0.646			
PRIN & INT LOW	6211.96	5.226	HIGH	4377.40	3.683
OPERATING COST LOW	14559.53	12.249	HIGH	12610.31	10.609
VEHICLE SALVAGE VALUE LOW	210.96	0.177	HIGH	210.96	0.177
BATTERY SALVAGE LOW	84.86	0.071	HIGH	84.86	0.071
TOTAL LIFE CYCLE COST LOW	15816.70	13.307	HIGH	13408.84	11.281

ELECTRIC AND HYBRID VEHICLE COST MODEL

ZN/BR 2-P EV - 60/KWH   09-12-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 2-PASS
CURB WEIGHT: 969 KG
VEHICLE WEIGHT, WT: 1105
LIFE: 118861.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 332 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2350948

NAME: ZN-BR2/2.1
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 17.4 KW
CONTROLLER: 28.6 KW

TYPE: ac

DRIVING --
ANNUAL ELEC USE: 2820.304 KW-H

AMOUNT: 11886.19 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM		
BASIC VEHICLE COST	4160.87	3.501		
MOTOR COST	330.60	0.278		
CONTROLLER COST	1287.00	1.083		
EV TRANSMISSION COST	132.99	0.112		
BATTERY LOW	869.24	0.731	HIGH 1755.86	1.477
INITIAL COST LOW	6780.69	5.705	HIGH 7667.32	6.451
DOWNPAYMENT LOW	1356.14	1.141	HIGH 1533.46	1.290
REPLACEM'T BATTS LOW	869.24	0.731	HIGH 1755.86	1.477
REPAIRS & MAINTENANCE	3527.35	2.968		
REPLACEMENT TIRES	230.23	0.194		
INSURANCE	3479.00	2.927		
GARAGING,PARK, TOLL	782.50	0.658		
TITLE, REG, LIC, LOW.	539.03	0.453	HIGH 583.37	0.491
ELECTRICITY	1410.15	1.186		
PRIN & INT LOW	5424.56	4.564	HIGH 6133.85	5.160
OPERATING COST LOW	16262.06	13.681	HIGH17015.68	14.316
VEHICLE SALVAGE VALUE LOW	723.24	0.608	HIGH 1228.47	1.034
BATTERY SALVAGE LOW	31.87	0.027	HIGH 31.87	0.027
TOTAL LIFE CYCLE COST LOW	16863.08	14.187	HIGH17288.81	14.545

ELECTRIC AND HYBRID VEHICLE COST MODEL

80-MI ZN/CL 2-P EV - EDA PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 2-PASS
CURB WEIGHT: 764 KG
VEHICLE WEIGHT , WT: 900
LIFE: 118861.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 189 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .22303

NAME: ZN-CL2/2.1
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 14.1 KW
CONTROLLER: 23.3 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 2111.795 KW-H

AMOUNT: 11886.19 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	3817.45	3.212			
MOTOR COST	267.90	0.225			
CONTROLLER COST	1048.50	0.882			
EV TRANSMISSION COST	108.35	0.091			
BATTERY LOW	2651.24	2.231	HIGH	0.00	0.000
INITIAL COST LOW	7893.43	6.641	HIGH	5242.19	4.410
DOWNPAYMENT LOW	1578.69	1.328	HIGH	1048.44	0.882
REPLACEM'T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	3527.35	2.968			
REPLACEMENT TIRES	214.53	0.180			
INSURANCE	3479.00	2.927			
GARAGING,PARK, TOLL	782.50	0.658			
TITLE, REG, LIC, LOW.	594.67	0.500	HIGH	462.11	0.389
ELECTRICITY	1055.90	0.888			
PRIN & INT LOW	6314.75	5.313	HIGH	4193.75	3.528
OPERATING COST LOW	15968.70	13.435	HIGH	13715.15	11.539
VEHICLE SALVAGE VALUE LOW	202.11	0.170	HIGH	202.11	0.170
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	17345.28	14.593	HIGH	14561.48	12.251

ELECTRIC AND HYBRID VEHICLE COST MODEL

80-MI FE/AIR 2-P EV - WESTINGHOUSE PROJECTIONS 08-29-1984

—INPUTS—

GENERAL --	YEAR: 1982
VEHICLE SIZE: 2-PASS	REAL INTEREST RATE: 10 %
CURB WEIGHT: 616 KG	VEHICLE SALVAGE VALUE: 10 %
VEHICLE WEIGHT , WT: 752	
LIFE: 118861.9 KM	ACCESSORY COST: $ 200
BATTERY —	NAME: FE-AIR2.1
BATTERY WEIGHT: 81 KG	BATTERY CYCLE LIFE: 500
ELECTRICITY COST: .05 $/KW-H	MAXIMUM SHELF LIFE: 10 YEARS
AVERAGE DAILY DEPTH OF DISCHARGE: .2322789	
	DEPTH OF A DEEP DISCHARGE: .8
MAINTENANCE FACTOR: 2	
TRANSMISSION TYPE: fixed ratio	
MOTOR —	
RATED POWER: 11.8 KW	TYPE: AC
CONTROLLER: 19.5 KW	
DRIVING —	AMOUNT: 11886.19 KM/YEAR
ANNUAL ELEC USE: 1458.678 KW-H	

— OUTPUTS —

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		3601.23	3.030			
MOTOR COST		224.20	0.189			
CONTROLLER COST		877.50	0.738			
EV TRANSMISSION COST		90.68	0.076			
BATTERY	LOW	723.48	0.609	HIGH	0.00	0.000
INITIAL COST	LOW	5517.08	4.642	HIGH	4793.61	4.033
DOWNPAYMENT	LOW	1103.42	0.928	HIGH	958.72	0.807
REPLACEM'T BATTS	LOW	1446.95	1.217	HIGH	0.00	0.000
REPAIRS & MAINTENANCE		3527.35	2.968			
REPLACEMENT TIRES		203.21	0.171			
INSURANCE		3479.00	2.927			
GARAGING,PARK, TOLL		782.50	0.658			
TITLE, REG, LIC,	LOW.	475.85	0.400	HIGH	439.68	0.370
ELECTRICITY		729.34	0.614			
PRIN & INT	LOW	4413.67	3.713	HIGH	3834.89	3.226
OPERATING COST	LOW	15057.87	12.668	HIGH	14442.92	12.151
VEHICLE SALVAGE VALUE	LOW	821.80	0.691	HIGH	184.81	0.155
BATTERY SALVAGE	LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST	LOW	15339.49	12.905	HIGH	15216.83	12.802

ELECTRIC AND HYBRID VEHICLE COST MODEL

80-MI LI/FES 2-P EV - ANL PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 2-PASS
CURB WEIGHT: 733 KG
VEHICLE WEIGHT , WT: 869
LIFE: 118861.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 164 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .1876562

NAME: LI-FE-S2.1
BATTERY CYCLE LIFE: 1000
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.25

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 13.7 KW
CONTROLLER: 22.5 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 1558.702 KW-H

AMOUNT: 11886.19 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	3787.56	3.187			
MOTOR COST	260.30	0.219			
CONTROLLER COST	1012.50	0.852			
EV TRANSMISSION COST	104.63	0.088			
BATTERY LOW	1926.18	1.621	HIGH	0.00	0.000
INITIAL COST LOW	7091.17	5.966	HIGH	5164.99	4.345
DOWNPAYMENT LOW	1418.23	1.193	HIGH	1033.00	0.869
REPLACEM'T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	2511.08	2.113			
REPLACEMENT TIRES	212.16	0.178			
INSURANCE	3479.00	2.927			
GARAGING,PARK, TOLL	782.50	0.658			
TITLE, REG, LIC, LOW.	554.56	0.467	HIGH	458.25	0.386
ELECTRICITY	779.35	0.656			
PRIN & INT LOW	5672.93	4.773	HIGH	4131.99	3.476
OPERATING COST LOW	13991.58	11.771	HIGH	12354.33	10.394
VEHICLE SALVAGE VALUE LOW	199.13	0.168	HIGH	199.13	0.168
BATTERY SALVAGE LOW	28.54	0.024	HIGH	28.54	0.024
TOTAL LIFE CYCLE COST LOW	15182.15	12.773	HIGH	13159.66	11.071

ELECTRIC AND HYBRID VEHICLE COST MODEL

80-MI NA/S 2-P EV - FORD PROJECTIONS 08-29-1984

--INPUTS--

GENERAL —
VEHICLE SIZE: 2-PASS
CURB WEIGHT: 658 KG
VEHICLE WEIGHT , WT: 794
LIFE: 118861.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY —
BATTERY WEIGHT: 111 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2365847

NAME: NA-S2.1
BATTERY CYCLE LIFE: 800
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.75

TRANSMISSION TYPE: fixed ratio
MOTOR —
RATED POWER: 12.5 KW
CONTROLLER: 20.6 KW

TYPE: AC

DRIVING —
ANNUAL ELEC USE: 1248.033 KW-H

AMOUNT: 11886.19 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	3666.26	3.084			
MOTOR COST	237.50	0.200			
CONTROLLER COST	927.00	0.780			
EV TRANSMISSION COST	95.79	0.081			
BATTERY LOW	2907.09	2.446	HIGH	0.00	0.000
INITIAL COST LOW	7833.64	6.591	HIGH	4926.55	4.145
DOWNPAYMENT LOW	1566.73	1.318	HIGH	985.31	0.829
REPLACEM'T BATTS LOW	2907.09	2.446	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	3188.59	2.683			
REPLACEMENT TIRES	206.42	0.174			
INSURANCE	3479.00	2.927			
GARAGING,PARK, TOLL	782.50	0.658			
TITLE, REG, LIC, LOW.	591.68	0.498	HIGH	446.33	0.376
ELECTRICITY	624.02	0.525			
PRIN & INT LOW	6266.91	5.272	HIGH	3941.24	3.316
OPERATING COST LOW	18046.22	15.183	HIGH	15575.19	13.104
VEHICLE SALVAGE VALUE LOW	2081.66	1.751	HIGH	189.94	0.160
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	17531.28	14.749	HIGH	16370.56	13.773

ELECTRIC AND HYBRID VEHICLE COST MODEL

PB/ACID 100-MI EV - 80/KWH   09-12-1984

—INPUTS—

GENERAL —
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1768 KG
VEHICLE WEIGHT , WT: 1904
LIFE: 132365.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY —
BATTERY WEIGHT: 590 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2124069

NAME: PBAC/AD2.4
BATTERY CYCLE LIFE: 800
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1

TRANSMISSION TYPE: fixed ratio
MOTOR —
RATED POWER: 48 KW
CONTROLLER: 53 KW

TYPE: ac

DRIVING —
ANNUAL ELEC USE: 2771.213 KW-H

AMOUNT: 13236.59 KM/YEAR

— OUTPUTS —

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	7299.54	5.515			
MOTOR COST	912.00	0.689			
CONTROLLER COST	2385.00	1.802			
EV TRANSMISSION COST	246.45	0.186			
BATTERY LOW	1748.28	1.321	HIGH	2097.93	1.585
INITIAL COST LOW	12591.27	9.512	HIGH	12940.93	9.777
DOWNPAYMENT LOW	2518.25	1.902	HIGH	2588.19	1.955
REPLACEM'T BATTS LOW	1748.28	1.321	HIGH	2097.93	1.585
REPAIRS & MAINTENANCE	2326.27	1.757			
REPLACEMENT TIRES	363.60	0.275			
INSURANCE	3479.00	2.628			
GARAGING,PARK, TOLL	782.50	0.591			
TITLE, REG, LIC, LOW.	829.56	0.627	HIGH	847.05	0.640
ELECTRICITY	1385.61	1.047			
PRIN & INT LOW	10073.01	7.610	HIGH	10352.74	7.821
OPERATING COST LOW	20987.83	15.856	HIGH	21285.04	16.080
VEHICLE SALVAGE VALUE LOW	1796.77	1.357	HIGH	2072.51	1.566
BATTERY SALVAGE LOW	40.16	0.030	HIGH	40.16	0.030
TOTAL LIFE CYCLE COST LOW	21669.17	16.371	HIGH	21760.56	16.440

ELECTRIC AND HYBRID VEHICLE COST MODEL

100-MI NI/FE 5-P EV - EPI PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1507 KG
VEHICLE WEIGHT , WT: 1643
LIFE: 132365.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 411 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2131295

NAME: NI-FE2.4
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.25

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 41.4 KW
CONTROLLER: 46 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 2674.277 KW-H

AMOUNT: 13236.59 KM/YEAR

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		6876.97	5.195			
MOTOR COST		786.60	0.594			
CONTROLLER COST		2070.00	1.564			
EV TRANSMISSION COST		213.90	0.162			
BATTERY	LOW	4080.11	3.082	HIGH	0.00	0.000
INITIAL COST	LOW	14027.58	10.598	HIGH	9947.47	7.515
DOWNPAYMENT	LOW	2805.52	2.120	HIGH	1989.50	1.503
REPLACEM'T BATTS	LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE		2703.51	2.042			
REPLACEMENT TIRES		338.67	0.256			
INSURANCE		3479.00	2.628			
GARAGING,PARK, TOLL		782.50	0.591			
TITLE, REG, LIC,	LOW.	901.38	0.681	HIGH	697.37	0.527
ELECTRICITY		1337.14	1.010			
PRIN & INT	LOW	11222.07	8.478	HIGH	7957.98	6.012
OPERATING COST	LOW	20764.27	15.687	HIGH	17296.18	13.067
VEHICLE SALVAGE VALUE	LOW	383.52	0.290	HIGH	383.52	0.290
BATTERY SALVAGE	LOW	150.98	0.114	HIGH	150.98	0.114
TOTAL LIFE CYCLE COST	LOW	23035.28	17.403	HIGH	18751.17	14.166

ELECTRIC AND HYBRID VEHICLE COST MODEL

ZN/BR 100-MI EV - 60/KWH 09-12-1984

--INPUTS--

GENERAL --
YEAR: 1982
VEHICLE SIZE: 5-PASS
REAL INTEREST RATE: 10 %
CURB WEIGHT: 1700 KG
VEHICLE SALVAGE VALUE: 10 %
VEHICLE WEIGHT , WT: 1836
LIFE: 132365.9 KM
ACCESSORY COST: $ 200

BATTERY --
NAME: ZN-BR2/2.4
BATTERY WEIGHT: 544 KG
BATTERY CYCLE LIFE: 750
ELECTRICITY COST: .05 $/KW-H
MAXIMUM SHELF LIFE: 10 YEARS
AVERAGE DAILY DEPTH OF DISCHARGE: .2387005
DEPTH OF A DEEP DISCHARGE: .8
MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 46.3 KW
TYPE: ac
CONTROLLER: 51.4 KW

DRIVING --
AMOUNT: 13236.59 KM/YEAR
ANNUAL ELEC USE: 4842.51 KW-H

-- OUTPUTS --

COST ITEMS-

	$	C/KM		
BASIC VEHICLE COST	7183.03	5.427		
MOTOR COST	879.70	0.665		
CONTROLLER COST	2313.00	1.747		
EV TRANSMISSION COST	239.01	0.181		
BATTERY LOW	1453.96	1.098	HIGH 2500.82	1.889
INITIAL COST LOW	12068.71	9.118	HIGH13115.56	9.909
DOWNPAYMENT LOW	2413.74	1.824	HIGH 2623.11	1.982
REPLACEM'T BATTS LOW	1453.96	1.098	HIGH 2500.82	1.889
REPAIRS & MAINTENANCE	3835.24	2.897		
REPLACEMENT TIRES	357.10	0.270		
INSURANCE	3479.00	2.628		
GARAGING,PARK, TOLL	782.50	0.591		
TITLE, REG, LIC, LOW.	803.44	0.607	HIGH 855.78	0.647
ELECTRICITY	2421.26	1.829		
PRIN & INT LOW	9654.97	7.294	HIGH10492.45	7.927
OPERATING COST LOW	22787.47	17.216	HIGH23677.29	17.888
VEHICLE SALVAGE VALUE LOW	1205.88	0.911	HIGH 1779.46	1.344
BATTERY SALVAGE LOW	53.31	0.040	HIGH 53.31	0.040
TOTAL LIFE CYCLE COST	LOW23942.02	18.088	HIGH24467.63	18.485

ELECTRIC AND HYBRID VEHICLE COST MODEL

100-MI ZN/CL 5-P EV - EDA PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1378 KG
VEHICLE WEIGHT , WT: 1514
LIFE: 132365.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 322 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2163071

NAME: ZN-CL2/2.4
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 38.2 KW
CONTROLLER: 42.4 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 3649.362 KW-H

AMOUNT: 13236.59 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM		$	C/KM
BASIC VEHICLE COST	6671.99	5.041			
MOTOR COST	725.80	0.548			
CONTROLLER COST	1908.00	1.441			
EV TRANSMISSION COST	197.16	0.149			
BATTERY LOW	3856.97	2.914	HIGH	0.00	0.000
INITIAL COST LOW	13359.93	10.093	HIGH	9502.95	7.179
DOWNPAYMENT LOW	2671.98	2.019	HIGH	1900.59	1.436
REPLACEM'T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	3835.24	2.897			
REPLACEMENT TIRES	326.35	0.247			
INSURANCE	3479.00	2.628			
GARAGING,PARK, TOLL	782.50	0.591			
TITLE, REG, LIC, LOW.	868.00	0.656	HIGH	675.15	0.510
ELECTRICITY	1824.68	1.379			
PRIN & INT LOW	10687.94	8.075	HIGH	7602.36	5.743
OPERATING COST LOW	21803.71	16.472	HIGH	18525.28	13.996
VEHICLE SALVAGE VALUE LOW	366.38	0.277	HIGH	366.38	0.277
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	24109.31	18.214	HIGH	20059.49	15.155

ELECTRIC AND HYBRID VEHICLE COST MODEL

100-MI FE/AIR 5-P EV - WESTINGHOUSE PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1153 KG
VEHICLE WEIGHT , WT: 1289
LIFE: 132365.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 168 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2091861

NAME: FE-AIR2.4
BATTERY CYCLE LIFE: 500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio

MOTOR --
RATED POWER: 32.5 KW
CONTROLLER: 36.1 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 2562.068 KW-H

AMOUNT: 13236.59 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	6307.74	4.765			
MOTOR COST	617.50	0.467			
CONTROLLER COST	1624.50	1.227			
EV TRANSMISSION COST	167.86	0.127			
BATTERY LOW	1332.62	1.007	HIGH	0.00	0.000
INITIAL COST LOW	10050.22	7.593	HIGH	8717.60	6.586
DOWNPAYMENT LOW	2010.04	1.519	HIGH	1743.52	1.317
REPLACEM'T BATTS LOW	1332.62	1.007	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	3835.24	2.897			
REPLACEMENT TIRES	304.86	0.230			
INSURANCE	3479.00	2.628			
GARAGING,PARK, TOLL	782.50	0.591			
TITLE, REG, LIC, LOW.	702.51	0.531	HIGH	635.88	0.480
ELECTRICITY	1281.03	0.968			
PRIN & INT LOW	8040.18	6.074	HIGH	6974.08	5.269
OPERATING COST LOW	19757.95	14.927	HIGH	18625.22	14.071
VEHICLE SALVAGE VALUE LOW	457.61	0.346	HIGH	336.10	0.254
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	21310.39	16.100	HIGH	20032.63	15.134

ELECTRIC AND HYBRID VEHICLE COST MODEL

100-MI LI/FES 5-P EV - ANL PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1338 KG
VEHICLE WEIGHT , WT: 1474
LIFE: 132365.9 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 295 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .1746534

NAME: LI-FE-S2.4
BATTERY CYCLE LIFE: 1000
MAXIMUM SHELF LIFE: 10 YEARS

DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.25

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 37.2 KW
CONTROLLER: 41.3 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 2688.873 KW-H

AMOUNT: 13236.59 KM/YEAR

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		6604.27	4.989			
MOTOR COST		706.80	0.534			
CONTROLLER COST		1858.50	1.404			
EV TRANSMISSION COST		192.05	0.145			
BATTERY	LOW	3464.78	2.618	HIGH	0.00	0.000
INITIAL COST	LOW	12826.39	9.690	HIGH	9361.61	7.073
DOWNPAYMENT	LOW	2565.28	1.938	HIGH	1872.32	1.415
REPLACEM'T BATTS	LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE		2703.51	2.042			
REPLACEMENT TIRES		322.53	0.244			
INSURANCE		3479.00	2.628			
GARAGING, PARK, TOLL		782.50	0.591			
TITLE, REG, LIC,	LOW.	841.32	0.636	HIGH	668.08	0.505
ELECTRICITY		1344.44	1.016			
PRIN & INT	LOW	10261.11	7.752	HIGH	7489.29	5.658
OPERATING COST	LOW	19734.40	14.909	HIGH	16789.35	12.684
VEHICLE SALVAGE VALUE	LOW	360.93	0.273	HIGH	360.93	0.273
BATTERY SALVAGE	LOW	51.33	0.039	HIGH	51.33	0.039
TOTAL LIFE CYCLE COST	LOW	21887.42	16.536	HIGH	18249.41	13.787

ELECTRIC AND HYBRID VEHICLE COST MODEL

100-MI NA/S 5-P EV - FORD PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1226 KG
VEHICLE WEIGHT , WT: 1362
LIFE: 130583.5 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 218 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .2175298

NAME: NA-S2.4
BATTERY CYCLE LIFE: 800
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.75

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 34.3 KW
CONTROLLER: 38.1 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 2155.389 KW-H

AMOUNT: 13058.35 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	6426.71	4.922			
MOTOR COST	651.70	0.499			
CONTROLLER COST	1714.50	1.313			
EV TRANSMISSION COST	177.16	0.136			
BATTERY LOW	3970.37	3.040	HIGH	0.00	0.000
INITIAL COST LOW	12940.45	9.910	HIGH	8970.07	6.869
DOWNPAYMENT LOW	2588.09	1.982	HIGH	1794.01	1.374
REPLACEM'T BATTS LOW	3970.37	3.040	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	3422.44	2.621			
REPLACEMENT TIRES	303.66	0.233			
INSURANCE	3479.00	2.664			
GARAGING,PARK, TOLL	782.50	0.599			
TITLE, REG, LIC, LOW.	847.02	0.649	HIGH	648.50	0.497
ELECTRICITY	1077.69	0.825			
PRIN & INT LOW	10352.36	7.928	HIGH	7176.06	5.495
OPERATING COST LOW	24235.04	18.559	HIGH	20860.23	15.975
VEHICLE SALVAGE VALUE LOW	3360.94	2.574	HIGH	345.84	0.265
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	23462.19	17.967	HIGH	22308.41	17.084

ELECTRIC AND HYBRID VEHICLE COST MODEL

PB/ACID 150-MI EV - 80/KWH 09-12-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 2366 KG
VEHICLE WEIGHT , WT: 2502
LIFE: 150106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 1001 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .1667522

NAME: PBAC/AD2.4
BATTERY CYCLE LIFE: 800
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 63 KW
CONTROLLER: 70 KW

TYPE: ac

DRIVING --
ANNUAL ELEC USE: 3862.698 KW-H

AMOUNT: 15010.67 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	8255.97	5.500			
MOTOR COST	1197.00	0.797			
CONTROLLER COST	3150.00	2.099			
EV TRANSMISSION COST	325.50	0.217			
BATTERY LOW	2966.15	1.976	HIGH	3559.37	2.371
INITIAL COST LOW	15894.62	10.589	HIGH	16487.85	10.984
DOWNPAYMENT LOW	3178.92	2.118	HIGH	3297.57	2.197
REPLACEM'T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	2633.01	1.754			
REPLACEMENT TIRES	530.49	0.353			
INSURANCE	3479.00	2.318			
GARAGING,PARK, TOLL	782.50	0.521			
TITLE, REG, LIC, LOW.	994.73	0.663	HIGH	1024.39	0.682
ELECTRICITY	1931.35	1.287			
PRIN & INT LOW	12715.69	8.471	HIGH	13190.28	8.787
OPERATING COST LOW	23066.77	15.367	HIGH	23571.02	15.703
VEHICLE SALVAGE VALUE LOW	498.45	0.332	HIGH	498.45	0.332
BATTERY SALVAGE LOW	68.13	0.045	HIGH	68.13	0.045
TOTAL LIFE CYCLE COST LOW	25679.12	17.107	HIGH	26302.01	17.522

ELECTRIC AND HYBRID VEHICLE COST MODEL

150-MI NI/FE 5-P EV - EPI PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --	YEAR: 1982
VEHICLE SIZE: 5-PASS	REAL INTEREST RATE: 10 %
CURB WEIGHT: 1853 KG	VEHICLE SALVAGE VALUE: 10 %
VEHICLE WEIGHT , WT: 1989	
LIFE: 150106.7 KM	ACCESSORY COST: $ 200
BATTERY --	NAME: NI-FE2.4
BATTERY WEIGHT: 648 KG	BATTERY CYCLE LIFE: 1500
ELECTRICITY COST: .05 $/KW-H	MAXIMUM SHELF LIFE: 10 YEARS
AVERAGE DAILY DEPTH OF DISCHARGE: .1662515	
	DEPTH OF A DEEP DISCHARGE: .8
MAINTENANCE FACTOR: 1.25	
TRANSMISSION TYPE: fixed ratio	
MOTOR --	
RATED POWER: 50.1 KW	TYPE: AC
CONTROLLER: 55.7 KW	
DRIVING --	AMOUNT: 15010.67 KM/YEAR
ANNUAL ELEC USE: 3510.207 KW-H	

-- OUTPUTS --

COST ITEMS-

		$	C/KM		$	C/KM
BASIC VEHICLE COST		7436.69	4.954			
MOTOR COST		951.90	0.634			
CONTROLLER COST		2506.50	1.670			
EV TRANSMISSION COST		259.01	0.173			
BATTERY	LOW	6432.87	4.286	HIGH	0.00	0.000
INITIAL COST	LOW	17586.97	11.716	HIGH	11154.09	7.431
DOWNPAYMENT	LOW	3517.39	2.343	HIGH	2230.82	1.486
REPLACEM'T BATTS	LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE		3094.59	2.062			
REPLACEMENT TIRES		468.71	0.312			
INSURANCE		3479.00	2.318			
GARAGING,PARK, TOLL		782.50	0.521			
TITLE, REG, LIC,	LOW.	1079.35	0.719	HIGH	757.70	0.505
ELECTRICITY		1755.10	1.169			
PRIN & INT	LOW	14069.57	9.373	HIGH	8923.27	5.945
OPERATING COST	LOW	24728.82	16.474	HIGH	19260.88	12.831
VEHICLE SALVAGE VALUE	LOW	430.04	0.286	HIGH	430.04	0.286
BATTERY SALVAGE	LOW	238.05	0.159	HIGH	238.05	0.159
TOTAL LIFE CYCLE COST	LOW	27578.13	18.372	HIGH	20823.61	13.873

ELECTRIC AND HYBRID VEHICLE COST MODEL

ZN/BR 150-MI EV - 60/KWH   09-12-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 2366 KG
VEHICLE WEIGHT , WT: 2502
LIFE: 150106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 1001 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .1979718

NAME: ZN-BR2/2.4
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS

DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 63.1 KW
CONTROLLER: 70.1 KW

TYPE: ac

DRIVING --
ANNUAL ELEC USE: 7463.92 KW-H

AMOUNT: 15010.67 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM		
BASIC VEHICLE COST	8253.79	5.499		
MOTOR COST	1198.90	0.799		
CONTROLLER COST	3154.50	2.102		
EV TRANSMISSION COST	325.97	0.217		
BATTERY LOW	2675.40	1.782	HIGH 4601.69	3.066
INITIAL COST LOW	15608.55	10.398	HIGH17534.84	11.682
DOWNPAYMENT LOW	3121.71	2.080	HIGH 3506.97	2.336
REPLACEM'T BATTS LOW	2675.40	1.782	HIGH 4601.69	3.066
REPAIRS & MAINTENANCE	4479.33	2.984		
REPLACEMENT TIRES	530.49	0.353		
INSURANCE	3479.00	2.318		
GARAGING,PARK, TOLL	782.50	0.521		
TITLE, REG, LIC, LOW.	980.43	0.653	HIGH 1076.74	0.717
ELECTRICITY	3731.96	2.486		
PRIN & INT LOW	12486.84	8.319	HIGH14027.87	9.345
OPERATING COST LOW	29145.95	19.417	HIGH30783.29	20.508
VEHICLE SALVAGE VALUE LOW	2627.37	1.750	HIGH 4160.06	2.771
BATTERY SALVAGE LOW	98.10	0.065	HIGH 98.10	0.065
TOTAL LIFE CYCLE COST LOW	29542.19	19.681	HIGH30032.10	20.007

ELECTRIC AND HYBRID VEHICLE COST MODEL

150-MI ZN/CL 5-P EV - EDA PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1717 KG
VEHICLE WEIGHT , WT: 1853
LIFE: 150106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 555 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .165164

NAME: ZN-CL2/2.4
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 46.7 KW
CONTROLLER: 51.9 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 4887.218 KW-H

AMOUNT: 15010.67 KM/YEAR

-- OUTPUTS --

COST ITEMS-

		$	C/KM		$	C/KM
BASIC VEHICLE COST		7215.22	4.807			
MOTOR COST		887.30	0.591			
CONTROLLER COST		2335.50	1.556			
EV TRANSMISSION COST		241.34	0.161			
BATTERY	LOW	6647.89	4.429	HIGH	0.00	0.000
INITIAL COST	LOW	17327.25	11.543	HIGH	10679.36	7.115
DOWNPAYMENT	LOW	3465.45	2.309	HIGH	2135.87	1.423
REPLACEM'T BATTS	LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE		4479.33	2.984			
REPLACEMENT TIRES		452.33	0.301			
INSURANCE		3479.00	2.318			
GARAGING,PARK, TOLL		782.50	0.521			
TITLE, REG, LIC,	LOW.	1066.36	0.710	HIGH	733.97	0.489
ELECTRICITY		2443.61	1.628			
PRIN & INT	LOW	13861.80	9.235	HIGH	8543.49	5.692
OPERATING COST	LOW	26564.93	17.697	HIGH	20914.22	13.933
VEHICLE SALVAGE VALUE	LOW	411.74	0.274	HIGH	411.74	0.274
BATTERY SALVAGE	LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST	LOW	29618.64	19.732	HIGH	22638.35	15.082

ELECTRIC AND HYBRID VEHICLE COST MODEL

150-MI FE/AIR 5-P EV - WESTINGHOUSE PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1266 KG
VEHICLE WEIGHT , WT: 1402
LIFE: 148805.8 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 245 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .1724618

NAME: FE-AIR2.4
BATTERY CYCLE LIFE: 500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 35.3 KW
CONTROLLER: 39.3 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 3166.333 KW-H

AMOUNT: 14880.58 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	6493.66	4.364			
MOTOR COST	670.70	0.451			
CONTROLLER COST	1768.50	1.188			
EV TRANSMISSION COST	182.75	0.123			
BATTERY LOW	1943.41	1.306	HIGH	0.00	0.000
INITIAL COST LOW	11059.02	7.432	HIGH	9115.61	6.126
DOWNPAYMENT LOW	2211.80	1.486	HIGH	1823.12	1.225
REPLACEM'T BATTS LOW	1943.41	1.306	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	4447.32	2.989			
REPLACEMENT TIRES	391.97	0.263			
INSURANCE	3479.00	2.338			
GARAGING,PARK, TOLL	782.50	0.526			
TITLE, REG, LIC, LOW.	752.95	0.506	HIGH	655.78	0.441
ELECTRICITY	1583.17	1.064			
PRIN & INT LOW	8847.21	5.945	HIGH	7292.49	4.901
OPERATING COST LOW	22227.53	14.937	HIGH	20575.64	13.827
VEHICLE SALVAGE VALUE LOW	1179.89	0.793	HIGH	351.45	0.236
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	23259.44	15.631	HIGH	22047.31	14.816

ELECTRIC AND HYBRID VEHICLE COST MODEL

150-MI LI/FES 5-P EV - ANL PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1507 KG
VEHICLE WEIGHT , WT: 1643
LIFE: 150106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 311 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .1464898

NAME: LI-FE-S2.4
BATTERY CYCLE LIFE: 1000
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.25

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 41.4 KW
CONTROLLER: 46 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 3289.512 KW-H

AMOUNT: 15010.67 KM/YEAR

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		7571.97	5.044			
MOTOR COST		786.60	0.524			
CONTROLLER COST		2070.00	1.379			
EV TRANSMISSION COST		213.90	0.142			
BATTERY	LOW	3652.70	2.433	HIGH	0.00	0.000
INITIAL COST	LOW	14295.17	9.523	HIGH	10642.48	7.090
DOWNPAYMENT	LOW	2859.03	1.905	HIGH	2128.49	1.418
REPLACEM'T BATTS	LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE		3094.59	2.062			
REPLACEMENT TIRES		427.04	0.284			
INSURANCE		3479.00	2.318			
GARAGING,PARK, TOLL		782.50	0.521			
TITLE, REG, LIC,	LOW.	914.76	0.609	HIGH	732.12	0.488
ELECTRICITY		1644.76	1.096			
PRIN & INT	LOW	11436.14	7.619	HIGH	8513.98	5.672
OPERATING COST	LOW	21778.78	14.509	HIGH	18673.99	12.440
VEHICLE SALVAGE VALUE	LOW	410.31	0.273	HIGH	410.31	0.273
BATTERY SALVAGE	LOW	54.11	0.036	HIGH	54.11	0.036
TOTAL LIFE CYCLE COST	LOW	24173.38	16.104	HIGH	20338.05	13.549

ELECTRIC AND HYBRID VEHICLE COST MODEL

150-MI NA/S 5-P EV - FORD PROJECTIONS 08-29-1984

—INPUTS—

GENERAL —		YEAR:	1982
VEHICLE SIZE:	5-PASS	REAL INTEREST RATE:	10 %
CURB WEIGHT:	1418 KG	VEHICLE SALVAGE VALUE:	10 %
VEHICLE WEIGHT , WT:	1554		
LIFE:	148487.7 KM	ACCESSORY COST:	$ 200
BATTERY —		NAME:	NA-S2.4
BATTERY WEIGHT:	350 KG	BATTERY CYCLE LIFE:	800
ELECTRICITY COST:	.05 $/KW-H	MAXIMUM SHELF LIFE:	10 YEARS
AVERAGE DAILY DEPTH OF DISCHARGE:	.1654134		
		DEPTH OF A DEEP DISCHARGE:	.8
MAINTENANCE FACTOR:	1.75		
TRANSMISSION TYPE:	fixed ratio		
MOTOR —			
RATED POWER:	39.2 KW	TYPE:	AC
CONTROLLER:	43.5 KW		
DRIVING —		AMOUNT:	14848.77 KM/YEAR
ANNUAL ELEC USE:	2687.817 KW-H		

— OUTPUTS —

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	6732.76	4.534			
MOTOR COST	744.80	0.502			
CONTROLLER COST	1957.50	1.318			
EV TRANSMISSION COST	202.28	0.136			
BATTERY LOW	6374.45	4.293	HIGH	0.00	0.000
INITIAL COST LOW	16011.79	10.783	HIGH	9637.34	6.490
DOWNPAYMENT LOW	3202.36	2.157	HIGH	1927.47	1.298
REPLACEM'T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	3982.90	2.682			
REPLACEMENT TIRES	408.46	0.275			
INSURANCE	3479.00	2.343			
GARAGING,PARK, TOLL	782.50	0.527			
TITLE, REG, LIC, LOW.	1000.59	0.674	HIGH	681.87	0.459
ELECTRICITY	1343.91	0.905			
PRIN & INT LOW	12809.44	8.627	HIGH	7709.87	5.192
OPERATING COST LOW	23806.79	16.033	HIGH	18388.50	12.384
VEHICLE SALVAGE VALUE LOW	371.56	0.250	HIGH	371.56	0.250
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	26637.58	17.939	HIGH	19944.41	13.432

ELECTRIC AND HYBRID VEHICLE COST MODEL

250-MI ZN/CL 5-P EV - EDA PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1763 KG
VEHICLE WEIGHT , WT: 1899
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 587 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .1036325

NAME: ZN-CL2/1.0
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 47.9 KW
CONTROLLER: 53.2 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 5459.819 KW-H

AMOUNT: 16610.67 KM/YEAR

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		7285.53	4.386			
MOTOR COST		910.10	0.548			
CONTROLLER COST		2394.00	1.441			
EV TRANSMISSION COST		247.38	0.149			
BATTERY	LOW	5812.50	3.499	HIGH	0.00	0.000
INITIAL COST	LOW	16649.51	10.023	HIGH	10837.01	6.524
DOWNPAYMENT	LOW	3329.90	2.005	HIGH	2167.40	1.305
REPLACEM'T BATTS	LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE		4604.53	2.772			
REPLACEMENT TIRES		543.32	0.327			
INSURANCE		3479.00	2.094			
GARAGING,PARK, TOLL		782.50	0.471			
TITLE, REG, LIC,	LOW.	1032.48	0.622	HIGH	741.85	0.447
ELECTRICITY		2729.91	1.643			
PRIN & INT	LOW	13319.61	8.019	HIGH	8669.60	5.219
OPERATING COST	LOW	26491.34	15.948	HIGH	21550.71	12.974
VEHICLE SALVAGE VALUE	LOW	417.81	0.252	HIGH	417.81	0.252
BATTERY SALVAGE	LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST	LOW	29403.43	17.702	HIGH	23300.30	14.027

ELECTRIC AND HYBRID VEHICLE COST MODEL

250-MI FE/AIR 5-P EV - WESTINGHOUSE PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1338 KG
VEHICLE WEIGHT , WT: 1474
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 295 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .1076719

NAME: FE-AIR1.0
BATTERY CYCLE LIFE: 500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

TRANSMISSION TYPE: fixed ratio
MOTOR --
RATED POWER: 37.2 KW
CONTROLLER: 41.3 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 3668.601 KW-H

AMOUNT: 16610.67 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	6604.27	3.976			
MOTOR COST	706.80	0.426			
CONTROLLER COST	1858.50	1.119			
EV TRANSMISSION COST	192.05	0.116			
BATTERY LOW	1747.47	1.052	HIGH	0.00	0.000
INITIAL COST LOW	11109.08	6.688	HIGH	9361.61	5.636
DOWNPAYMENT LOW	2221.82	1.338	HIGH	1872.32	1.127
REPLACEM'T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	4604.53	2.772			
REPLACEMENT TIRES	482.58	0.291			
INSURANCE	3479.00	2.094			
GARAGING,PARK, TOLL	782.50	0.471			
TITLE, REG, LIC, LOW.	755.45	0.455	HIGH	668.08	0.402
ELECTRICITY	1834.30	1.104			
PRIN & INT LOW	8887.27	5.350	HIGH	7489.29	4.509
OPERATING COST LOW	20825.64	12.538	HIGH	19340.28	11.643
VEHICLE SALVAGE VALUE LOW	360.93	0.217	HIGH	360.93	0.217
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	22686.52	13.658	HIGH	20851.67	12.553

ELECTRIC AND HYBRID VEHICLE COST MODEL

250-MI LI/FES 5-P EV - ANL PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --		YEAR:	1982
VEHICLE SIZE:	5-PASS	REAL INTEREST RATE:	10 %
CURB WEIGHT:	1526 KG	VEHICLE SALVAGE VALUE:	10 %
VEHICLE WEIGHT , WT:	1662		
LIFE:	166106.7 KM	ACCESSORY COST:	$ 200
BATTERY --		NAME:	LI-FE-S1.0
BATTERY WEIGHT:	424 KG	BATTERY CYCLE LIFE:	1000
ELECTRICITY COST:	.05 $/KW-H	MAXIMUM SHELF LIFE:	10 YEARS
AVERAGE DAILY DEPTH OF DISCHARGE:	.1020079		
		DEPTH OF A DEEP DISCHARGE:	.8
MAINTENANCE FACTOR:	1.25		
TRANSMISSION TYPE:	fixed ratio		
MOTOR --			
RATED POWER:	41.9 KW	TYPE:	AC
CONTROLLER:	46.5 KW		
DRIVING --		AMOUNT:	16610.67 KM/YEAR
ANNUAL ELEC USE:	3655.433 KW-H		

-- OUTPUTS --

COST ITEMS-

	$	C/KM		$	C/KM
BASIC VEHICLE COST	6907.75	4.159			
MOTOR COST	796.10	0.479			
CONTROLLER COST	2092.50	1.260			
EV TRANSMISSION COST	216.23	0.130			
BATTERY LOW	7784.64	4.687	HIGH	0.00	0.000
INITIAL COST LOW	17797.21	10.714	HIGH	10012.57	6.028
DOWNPAYMENT LOW	3559.44	2.143	HIGH	2002.51	1.206
REPLACEM'T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	3184.32	1.917			
REPLACEMENT TIRES	509.45	0.307			
INSURANCE	3479.00	2.094			
GARAGING,PARK, TOLL	782.50	0.471			
TITLE, REG, LIC, LOW.	1089.86	0.656	HIGH	700.63	0.422
ELECTRICITY	1827.72	1.100			
PRIN & INT LOW	14237.77	8.571	HIGH	8010.06	4.822
OPERATING COST LOW	25110.61	15.117	HIGH	18493.67	11.134
VEHICLE SALVAGE VALUE LOW	386.03	0.232	HIGH	386.03	0.232
BATTERY SALVAGE LOW	115.33	0.069	HIGH	115.33	0.069
TOTAL LIFE CYCLE COST LOW	28168.70	16.958	HIGH	19994.83	12.037

ELECTRIC AND HYBRID VEHICLE COST MODEL

250-MI NA/S 5-P EV - FORD PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1470 KG
VEHICLE WEIGHT , WT: 1606
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 385 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .1094112

NAME: NA-S1.0
BATTERY CYCLE LIFE: 800
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.75

TRANSMISSION TYPE: fixed ratio

MOTOR --
RATED POWER: 40.5 KW
CONTROLLER: 45 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 3037.261 KW-H

AMOUNT: 16610.67 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	6820.96	4.106			
MOTOR COST	769.50	0.463			
CONTROLLER COST	2025.00	1.219			
EV TRANSMISSION COST	209.25	0.126			
BATTERY LOW	6081.08	3.661	HIGH	0.00	0.000
INITIAL COST LOW	15905.79	9.576	HIGH	9824.71	5.915
DOWNPAYMENT LOW	3181.16	1.915	HIGH	1964.94	1.183
REPLACEM'T BATTS LOW	0.00	0.000	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	4131.13	2.487			
REPLACEMENT TIRES	501.44	0.302			
INSURANCE	3479.00	2.094			
GARAGING,PARK, TOLL	782.50	0.471			
TITLE, REG, LIC, LOW.	995.29	0.599	HIGH	691.24	0.416
ELECTRICITY	1518.63	0.914			
PRIN & INT LOW	12724.63	7.661	HIGH	7859.77	4.732
OPERATING COST LOW	24132.63	14.528	HIGH	18963.71	11.417
VEHICLE SALVAGE VALUE LOW	378.79	0.228	HIGH	378.79	0.228
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	26935.00	16.215	HIGH	20549.87	12.371

ELECTRIC AND HYBRID VEHICLE COST MODEL

AL/AIR - LLNL PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1507 KG
VEHICLE WEIGHT , WT: 1643
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 411 KG
ELECTRICITY COST: 0 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .1028866

NAME: AL-AIR
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2.25

TRANSMISSION TYPE: fixed ratio

MOTOR --
RATED POWER: 41.4 KW
CONTROLLER: 46 KW

TYPE: AC

DRIVING --
ANNUAL ELEC USE: 10119.13 KW-H

AMOUNT: 16610.67 KM/YEAR

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	6876.97	4.140			
MOTOR COST	786.60	0.474			
CONTROLLER COST	2070.00	1.246			
EV TRANSMISSION COST	213.90	0.129			
BATTERY LOW	3909.73	2.354	HIGH	0.00	0.000
INITIAL COST LOW	13857.21	8.342	HIGH	9947.47	5.989
DOWNPAYMENT LOW	2771.44	1.668	HIGH	1989.50	1.198
REPLACEM'T BATTS LOW	5555.08	3.344	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	5077.94	3.057			
REPLACEMENT TIRES	506.73	0.305			
INSURANCE	3479.00	2.094			
GARAGING,PARK, TOLL	782.50	0.471			
TITLE, REG, LIC, LOW.	892.86	0.538	HIGH	697.37	0.420
ELECTRICITY	10381.67	6.250			
PRIN & INT LOW	11085.76	6.674	HIGH	7957.98	4.791
OPERATING COST LOW	37761.54	22.733	HIGH	34438.27	20.733
VEHICLE SALVAGE VALUE LOW	383.52	0.231	HIGH	383.52	0.231
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	40149.46	24.171	HIGH	36044.24	21.699

ELECTRIC AND HYBRID VEHICLE COST MODEL

PB/ACID HYBRID - 80/KWH 09-12-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1747 KG
VEHICLE WEIGHT , WT: 1883
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 410 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .3336073
MAINTENANCE FACTOR: 1

NAME: PBAC/AD3.3
BATTERY CYCLE LIFE: 800
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

ENGINE --
TANK CAPACITY: 40 L
ICE TRANSMISSION TYPE: CVT

FUEL COST: .373 $/L
FUEL TYPE: METHANOL
POWER: 52.7 KW

MOTOR --
RATED POWER: 47.5 KW
CONTROLLER: 52.7 KW
EV TRANSMISSION TYPE: fixed ratio

TYPE: ac
POWER: 52.7 KW

DRIVING --
ICE FRACTIONAL RANGE: 22.2 %
ANNUAL FUEL USE: 486.0283 L

AMOUNT: 16610.67 KM/YEAR
EV FRACTIONAL RANGE: 74.3 %
ANNUAL ELEC USE: 2635.126 KW-H

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		7267.10	4.375			
ENGINE COST		1331.99	0.802			
ICE TRANSMISSION COST		588.66	0.354			
MOTOR COST		902.50	0.543			
CONTROLLER COST		2371.50	1.428			
EV TRANSMISSION COST		245.06	0.148			
BATTERY	LOW	1126.01	0.678	HIGH	1430.03	0.861
INITIAL COST	LOW	13832.81	8.328	HIGH	14136.83	8.511
DOWNPAYMENT	LOW	2766.56	1.666	HIGH	2827.37	1.702
REPLACEM'T BATTS	LOW	1126.01	0.678	HIGH	1430.03	0.861
REPAIRS & MAINTENANCE		4290.78	2.583			
REPLACEMENT TIRES		541.03	0.326			
INSURANCE		3479.00	2.094			
GARAGING, PARK, TOLL		782.50	0.471			
TITLE, REG, LIC,	LOW.	891.64	0.537	HIGH	906.84	0.546
FUEL-OIL		1867.27	1.124			
ELECTRICITY		1317.56	0.793			
PRIN & INT	LOW	11066.24	6.662	HIGH	11309.46	6.809
OPERATING COST	LOW	25362.04	15.269	HIGH	25620.46	15.424
VEHICLE SALVAGE VALUE	LOW	599.57	0.361	HIGH	629.18	0.379
BATTERY SALVAGE	LOW	25.86	0.016	HIGH	25.86	0.016
TOTAL LIFE CYCLE COST	LOW	27503.17	16.558	HIGH	27792.78	16.732

ELECTRIC AND HYBRID VEHICLE COST MODEL

NI/FE HYBRID - EPI PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1529 KG
VEHICLE WEIGHT , WT: 1665
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 280 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .3478479

NAME: NI-FE3.3
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS

DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 1.25

ENGINE --
TANK CAPACITY: 40 L
ICE TRANSMISSION TYPE: CVT

FUEL COST: .373 $/L
FUEL TYPE: METHANOL
POWER: 46.6 KW

MOTOR --
RATED POWER: 42 KW
CONTROLLER: 46.6 KW
EV TRANSMISSION TYPE: fixed ratio

TYPE: AC

DRIVING --
ICE FRACTIONAL RANGE: 22.15058 %
ANNUAL FUEL USE: 447.3148 L

AMOUNT: 16610.67 KM/YEAR
EV FRACTIONAL RANGE: 74.30828 %
ANNUAL ELEC USE: 2552.365 KW-H

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		6913.07	4.162			
ENGINE COST		1279.00	0.770			
ICE TRANSMISSION COST		520.52	0.313			
MOTOR COST		798.00	0.480			
CONTROLLER COST		2097.00	1.262			
EV TRANSMISSION COST		216.69	0.130			
BATTERY	LOW	2481.82	1.494	HIGH	0.00	0.000
INITIAL COST	LOW	14306.10	8.613	HIGH	11824.28	7.118
DOWNPAYMENT	LOW	2861.22	1.723	HIGH	2364.86	1.424
REPLACEM'T BATTS	LOW	2481.82	1.494	HIGH	0.00	0.000
REPAIRS & MAINTENANCE		4641.15	2.794			
REPLACEMENT TIRES		509.88	0.307			
INSURANCE		3479.00	2.094			
GARAGING,PARK, TOLL		782.50	0.471			
TITLE, REG, LIC,	LOW.	915.31	0.551	HIGH	791.21	0.476
FUEL-OIL		1718.54	1.035			
ELECTRICITY		1276.18	0.768			
PRIN & INT	LOW	11444.88	6.890	HIGH	9459.43	5.695
OPERATING COST	LOW	27249.25	16.405	HIGH	25139.71	15.135
VEHICLE SALVAGE VALUE	LOW	2793.66	1.682	HIGH	455.88	0.274
BATTERY SALVAGE	LOW	91.84	0.055	HIGH	91.84	0.055
TOTAL LIFE CYCLE COST	LOW	27224.98	16.390	HIGH	26956.85	16.229

ELECTRIC AND HYBRID VEHICLE COST MODEL

ZN/BR HYBRID - 60/KWH   09-12-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1783 KG
VEHICLE WEIGHT , WT: 1919
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %
ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 432 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .3634617
MAINTENANCE FACTOR: 2

NAME: ZN-BR2/3.3
BATTERY CYCLE LIFE: 750
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

ENGINE --
TANK CAPACITY: 40 L
ICE TRANSMISSION TYPE: CVT

FUEL COST: .373 $/L
FUEL TYPE: METHANOL
POWER: 53.7 KW

MOTOR --
RATED POWER: 48.4 KW
CONTROLLER: 53.7 KW
EV TRANSMISSION TYPE: fixed ratio

TYPE: ac
POWER: 53.7 KW

DRIVING --
ICE FRACTIONAL RANGE: 22.2 %
ANNUAL FUEL USE: 512.1392 L

AMOUNT: 16610.67 KM/YEAR
EV FRACTIONAL RANGE: 74.5 %
ANNUAL ELEC USE: 4647.743 KW-H

-- OUTPUTS --

COST ITEMS-

		$	C/KM			
BASIC VEHICLE COST		7322.19	4.408			
ENGINE COST		1340.28	0.807			
ICE TRANSMISSION COST		599.83	0.361			
MOTOR COST		919.60	0.554			
CONTROLLER COST		2416.50	1.455			
EV TRANSMISSION COST		249.71	0.150			
BATTERY	LOW	942.55	0.567	HIGH	1724.86	1.038
		-------	------			
INITIAL COST	LOW	13790.65	8.302	HIGH	14572.96	8.773
DOWNPAYMENT	LOW	2758.13	1.660	HIGH	2914.59	1.755
REPLACEM'T BATTS	LOW	1885.09	1.135	HIGH	3449.72	2.077
REPAIRS & MAINTENANCE		5705.31	3.435			
REPLACEMENT TIRES		546.18	0.329			
INSURANCE		3479.00	2.094			
GARAGING,PARK, TOLL		782.50	0.471			
TITLE, REG, LIC,	LOW.	889.53	0.536	HIGH	928.65	0.559
FUEL-OIL		1967.59	1.185			
ELECTRICITY		2323.87	1.399			
PRIN & INT	LOW	11032.52	6.642	HIGH	11658.37	7.019
		-------	------			
OPERATING COST	LOW	28611.59	17.225	HIGH	29276.56	17.625
VEHICLE SALVAGE VALUE	LOW	1238.96	0.746	HIGH	1856.16	1.117
BATTERY SALVAGE	LOW	69.12	0.042	HIGH	69.12	0.042
TOTAL LIFE CYCLE COST	LOW	30061.63	18.098	HIGH	30265.86	18.221

ELECTRIC AND HYBRID VEHICLE COST MODEL

ZN/CL HYBRID - EDA PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1517 KG
VEHICLE WEIGHT , WT: 1653
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 273 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .3518266

NAME: ZN-CL2/3.3
BATTERY CYCLE LIFE: 1500
MAXIMUM SHELF LIFE: 10 YEARS
DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

ENGINE --
TANK CAPACITY: 40 L
ICE TRANSMISSION TYPE: CVT

FUEL COST: .373 $/L
FUEL TYPE: METHANOL
POWER: 46.3 KW

MOTOR --
RATED POWER: 41.7 KW
CONTROLLER: 46.3 KW
EV TRANSMISSION TYPE: fixed ratio

TYPE: AC

DRIVING --
ICE FRACTIONAL RANGE: 22.15058 %
ANNUAL FUEL USE: 444.8058 L

AMOUNT: 16610.67 KM/YEAR
EV FRACTIONAL RANGE: 77.51238 %
ANNUAL ELEC USE: 3865.076 KW-H

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	6891.41	4.149			
ENGINE COST	1276.27	0.768			
ICE TRANSMISSION COST	517.17	0.311			
MOTOR COST	792.30	0.477			
CONTROLLER COST	2083.50	1.254			
EV TRANSMISSION COST	215.30	0.130			
BATTERY LOW	3611.79	2.174	HIGH	0.00	0.000
INITIAL COST LOW	15387.74	9.264	HIGH	11775.95	7.089
DOWNPAYMENT LOW	3077.55	1.853	HIGH	2355.19	1.418
REPLACEM'T BATTS LOW	3611.79	2.174	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	5817.83	3.502			
REPLACEMENT TIRES	508.16	0.306			
INSURANCE	3479.00	2.094			
GARAGING, PARK, TOLL	782.50	0.471			
TITLE, REG, LIC, LOW.	969.39	0.584	HIGH	788.80	0.475
FUEL-OIL	1708.90	1.029			
ELECTRICITY	1932.54	1.163			
PRIN & INT LOW	12310.19	7.411	HIGH	9420.76	5.672
OPERATING COST LOW	31120.30	18.735	HIGH	28050.27	16.887
VEHICLE SALVAGE VALUE LOW	3812.47	2.295	HIGH	454.01	0.273
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	30385.37	18.293	HIGH	29951.45	18.031

ELECTRIC AND HYBRID VEHICLE COST MODEL

FE/AIR HYBRID - WESTINGHOUSE PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --
VEHICLE SIZE: 5-PASS
CURB WEIGHT: 1257 KG
VEHICLE WEIGHT , WT: 1393
LIFE: 166106.7 KM

YEAR: 1982
REAL INTEREST RATE: 10 %
VEHICLE SALVAGE VALUE: 10 %

ACCESSORY COST: $ 200

BATTERY --
BATTERY WEIGHT: 117 KG
ELECTRICITY COST: .05 $/KW-H
AVERAGE DAILY DEPTH OF DISCHARGE: .3796501

NAME: FE-AIR3.3
BATTERY CYCLE LIFE: 500
MAXIMUM SHELF LIFE: 10 YEARS

DEPTH OF A DEEP DISCHARGE: .8

MAINTENANCE FACTOR: 2

ENGINE --
TANK CAPACITY: 40 L
ICE TRANSMISSION TYPE: CVT

FUEL COST: .373 $/L
FUEL TYPE: METHANOL
POWER: 39 KW

MOTOR --
RATED POWER: 35.1 KW
CONTROLLER: 39 KW
EV TRANSMISSION TYPE: fixed ratio

TYPE: AC

DRIVING --
ICE FRACTIONAL RANGE: 22.15058 %
ANNUAL FUEL USE: 393.7921 L

AMOUNT: 16610.67 KM/YEAR
EV FRACTIONAL RANGE: 75.94268 %
ANNUAL ELEC USE: 2551.061 KW-H

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	6477.11	3.899			
ENGINE COST	1206.02	0.726			
ICE TRANSMISSION COST	435.63	0.262			
MOTOR COST	666.90	0.401			
CONTROLLER COST	1755.00	1.057			
EV TRANSMISSION COST	181.35	0.109			
BATTERY LOW	1035.29	0.623	HIGH	0.00	0.000
INITIAL COST LOW	11757.30	7.078	HIGH	10722.01	6.455
DOWNPAYMENT LOW	2351.46	1.416	HIGH	2144.40	1.291
REPLACEM'T BATTS LOW	3105.87	1.870	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	5758.38	3.467			
REPLACEMENT TIRES	471.00	0.284			
INSURANCE	3479.00	2.094			
GARAGING,PARK, TOLL	782.50	0.471			
TITLE, REG, LIC, LOW.	787.86	0.474	HIGH	736.10	0.443
FUEL-OIL	1512.91	0.911			
ELECTRICITY	1275.53	0.768			
PRIN & INT LOW	9405.84	5.663	HIGH	8577.61	5.164
OPERATING COST LOW	26578.91	16.001	HIGH	25698.91	15.471
VEHICLE SALVAGE VALUE LOW	967.98	0.583	HIGH	413.38	0.249
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	27962.39	16.834	HIGH	27429.93	16.513

ELECTRIC AND HYBRID VEHICLE COST MODEL

LI/FES HYBRID - ANL PROJECTIONS 08-29-1984

--INPUTS--

GENERAL --		YEAR:	1982
VEHICLE SIZE:	5-PASS	REAL INTEREST RATE:	10 %
CURB WEIGHT:	1368 KG	VEHICLE SALVAGE VALUE:	10 %
VEHICLE WEIGHT , WI:	1504		
LIFE:	166106.7 KM	ACCESSORY COST:	$ 200
BATTERY --		NAME:	LI-FE-S3.3
BATTERY WEIGHT:	184 KG	BATTERY CYCLE LIFE:	1000
ELECTRICITY COST:	.05 $/KW-H	MAXIMUM SHELF LIFE:	10 YEARS
AVERAGE DAILY DEPTH OF DISCHARGE:	.22164		
		DEPTH OF A DEEP DISCHARGE:	.8
MAINTENANCE FACTOR:	1.25		
ENGINE --		FUEL COST:	.373 $/L
TANK CAPACITY:	40 L	FUEL TYPE:	METHANOL
ICE TRANSMISSION TYPE:	CVT	POWER:	42.1 KW
MOTOR --			
RATED POWER:	37.9 KW	TYPE:	AC
CONTROLLER:	42.1 KW		
EV TRANSMISSION TYPE:	fixed ratio		
DRIVING --		AMOUNT:	16610.67 KM/YEAR
ICE FRACTIONAL RANGE:	22.15058 %	EV FRACTIONAL RANGE:	75.5597 %
ANNUAL FUEL USE:	415.3776 L	ANNUAL ELEC USE:	2639.009 KW-H

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	6651.94	4.005			
ENGINE COST	1236.85	0.745			
ICE TRANSMISSION COST	470.26	0.283			
MOTOR COST	720.10	0.434			
CONTROLLER COST	1894.50	1.141			
EV TRANSMISSION COST	195.77	0.118			
BATTERY LOW	3924.22	2.362	HIGH	0.00	0.000
INITIAL COST LOW	15093.63	9.087	HIGH	11169.41	6.724
DOWNPAYMENT LOW	3018.73	1.817	HIGH	2233.88	1.345
REPLACEM'T BATTS LOW	3924.22	2.362	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	4670.77	2.812			
REPLACEMENT TIRES	486.87	0.293			
INSURANCE	3479.00	2.094			
GARAGING,PARK, TOLL	782.50	0.471			
TITLE, REG, LIC, LOW.	954.68	0.575	HIGH	758.47	0.457
FUEL-OIL	1595.84	0.961			
ELECTRICITY	1319.50	0.794			
PRIN & INT LOW	12074.90	7.269	HIGH	8935.53	5.379
OPERATING COST LOW	29283.28	17.632	HIGH	25952.70	15.624
VEHICLE SALVAGE VALUE LOW	4310.77	2.595	HIGH	430.63	0.259
BATTERY SALVAGE LOW	50.05	0.030	HIGH	50.05	0.030
TOTAL LIFE CYCLE COST LOW	27946.19	16.824	HIGH	27705.90	16.680

ELECTRIC AND HYBRID VEHICLE COST MODEL

NA/S HYBRID - FORD PROJECTIONS 08-29-1984

--INPUTS--

GENERAL -- YEAR: 1982
VEHICLE SIZE: 5-PASS REAL INTEREST RATE: 10 %
CURB WEIGHT: 1327 KG VEHICLE SALVAGE VALUE: 10 %
VEHICLE WEIGHT , WT: 1463
LIFE: 166106.7 KM ACCESSORY COST: $ 200

BATTERY -- NAME: NA-S3.3
BATTERY WEIGHT: 159 KG BATTERY CYCLE LIFE: 800
ELECTRICITY COST: .05 $/KW-H MAXIMUM SHELF LIFE: 10 YEARS
AVERAGE DAILY DEPTH OF DISCHARGE: .3693321
DEPTH OF A DEEP DISCHARGE: .8
MAINTENANCE FACTOR: 1.75

ENGINE -- FUEL COST: .373 $/L
TANK CAPACITY: 40 L FUEL TYPE: METHANOL
ICE TRANSMISSION TYPE: CVT POWER: 41 KW

MOTOR --
RATED POWER: 36.9 KW TYPE: AC
CONTROLLER: 41 KW
EV TRANSMISSION TYPE: fixed ratio

DRIVING -- AMOUNT: 16610.67 KM/YEAR
ICE FRACTIONAL RANGE: 22.15058 % EV FRACTIONAL RANGE: 76.46053 %
ANNUAL FUEL USE: 406.854 L ANNUAL ELEC USE: 2208.89 KW-H

-- OUTPUTS --

COST ITEMS-

	$	C/KM			
BASIC VEHICLE COST	6587.31	3.966			
ENGINE COST	1226.09	0.738			
ICE TRANSMISSION COST	457.97	0.276			
MOTOR COST	701.10	0.422			
CONTROLLER COST	1845.00	1.111			
EV TRANSMISSION COST	190.65	0.115			
BATTERY LOW	3291.95	1.982	HIGH	0.00	0.000
INITIAL COST LOW	14300.06	8.609	HIGH	11008.11	6.627
DOWNPAYMENT LOW	2860.01	1.722	HIGH	2201.62	1.325
REPLACEM'T BATTS LOW	6583.90	3.964	HIGH	0.00	0.000
REPAIRS & MAINTENANCE	5416.03	3.261			
REPLACEMENT TIRES	481.01	0.290			
INSURANCE	3479.00	2.094			
GARAGING,PARK, TOLL	782.50	0.471			
TITLE, REG, LIC, LOW.	915.00	0.551	HIGH	750.41	0.452
FUEL-OIL	1563.09	0.941			
ELECTRICITY	1104.45	0.665			
PRIN & INT LOW	11440.05	6.887	HIGH	8806.49	5.302
OPERATING COST LOW	31765.03	19.123	HIGH	28966.87	17.439
VEHICLE SALVAGE VALUE LOW	3366.27	2.027	HIGH	424.41	0.256
BATTERY SALVAGE LOW	0.00	0.000	HIGH	0.00	0.000
TOTAL LIFE CYCLE COST LOW	31258.77	18.818	HIGH	30744.09	18.509

APPENDIX F

DESIGN AND ANALYSIS OF FUEL-CELL VEHICLES

DESIGN AND ANALYSIS OF FUEL-CELL VEHICLES

The fuel-cell vehicles in this assessment were not designed in the same manner as the other advanced vehicles. The AVSIZING program is not capable of automatically designing the fuel-cell vehicles, and the ELVEC program is comprised of only specific 20-kW designs that are not scaleable, making several assumptions necessary. This section details the assumptions and the procedure used in the assessment.

(1) The relative efficiency of a fuel cell compared to a heat engine remains constant with power level. This assumption is basic to understanding the approach because it implies that the fuel efficiency of a specific fuel-cell-powered vehicle can be estimated by simulating a heat-engine-powered vehicle of the same weight and adjusting for the efficiency difference and the warm-up requirements. For example, the relative efficiencies are:

(a) Solid polymer electrolyte (SPE) Fuel cell: 51% continuous

(b) Phosphoric acid fuel cell (PAFC): 56% continuous

(c) High-compession spark-ignition engine: 16 to 20%

Therefore, the SPE-powered vehicle would get approximately 51/18 (or 2.8) times the fuel economy of an ICE-powered vehicle of the same weight, without the warm-up fuel adjustment.

(2) The warm-up fuel consumption can be scaled linearly from the values supplied by General Electric (GE) for the SPE and United Technologies Corporation (UTC) for the PAFC (References F-1 and F-2) based on the power rating of the fuel processor and the estimated number of complete and partial warm-ups over a year. For example, the PAFC system was assumed to cool-down about 80% each day with about 320 days of operation per year. Based on the UTC value of 0.46 gal per warm-up, this would imply 117 gal/year. Similarly, a 20-kW SPE system was estimated by GE to consume 0.084 gal per start-up and using 2 starts per day for 320 days implies over 50 gallons. In these analyses, the grade requirement drives the continuous rating to about 40 kW, implying that over 100 gal would be required per year.

(3) Subcomponents of the SPE system could be scaled linearly with power rating, exclusive of the cell stack.

(4) The SPE cell stack could operate intermittently at 1000 ASF for grades and other maneuvers if the other subcomponents were sized to supply the fuel and cooling requirements. (The basic GE assumption of 60:1 charge/discharge time of the hydrogen and oxygen tanks has not been changed.) This assumption implies that a vehicle requiring 40 kW could use a system with a cell stack originally designed for a 20-kW system, but with the fuel processor and cooling subcomponents for a 40-kW system. The system cost is dramatically reduced; however, the effect on life

is uncertain and would depend on the duty cycle at the high rates. This assumption was necessary because linear scaling of the system as described by GE produced exceptionally high costs. The original study by GE for Los Alamos National Laboratory did not consider a vehicle grade requirement, assumed that all high-power operation would last no longer than 20 s, and the demand would occur no more often than 10 min (i.e., the 60:1 charge/discharge ratio). The typical vehicle is capable of a 7% grade at 88 km/h and the advanced vehicle (AV) requirement is for 3.3 min. Therefore, the fuel cell must be sized for continuous operation at the power level required for gradability (about 28 W/kg of vehicle test weight). With the increased system power, the 200% overload capability is not necessary, and the tanks were sized for 50% overload. The basic cell-stack design was not disturbed, and the same cell stack was assumed for various systems. However, the duty cycle on the stack varies with system size as shown in Table F-1.

The sales price of a 40-kW plant with 200% overload capability would be $13,200 (2 x $6600), using the linear scaling approach. The advantage of using the listed weights and costs is apparent and is critical to the comparative analyses. If these assumptions are ambitious, the SPE system will not look as good as it is portrayed in the assessment.

(5) Fuel-cell/battery, load-leveled systems were also considered because of the uncertainty of the sizing assumptions and the unfavorable cost analyses resulting from the costly fuel cells. In addition, the PAFC system designed for full power could not be

Table F-1. Solid Polymer Electrolyte Fuel-Cell Scaling Assumptions

	SPE continuous rating, kW		
Characteristics	20	30	40
20-s rating, kW	30	45	60
H_2/O_2 stored energy, kW-s	600	900	1200
Weight, kg	155	185	220
Component box volume, 1	140	175	210
with 60% packing factor	230	290	350
Manufacturing cost, 1982$	3300	3510	3720
OEM price, 1982$	4300	4600	4800
Sales price, 1982$	6600	7020	7440

packaged in the vehicle assumed in the AV Assessment. The impact of load-leveling the fuel cells with batteries that would provide the peak-power requirements were approximated by looking at the gross differences in the systems. For example, assuming vehicles designed with the same performance, the load-leveled vehicle would use a smaller fuel cell (20 kW in all cases) but would incur the battery costs. The differences are summarized in Table F-2 for SPE and PA vehicles.

The load-leveled SPE system is not better than the basic SPE system because of the already bold assumptions concerning the operation of the cell stack. However, it is substantially better than designing a vehicle with a 40-kW system based on the linear sizing and costing approach (approximately $6000 savings). Therefore, if operating the cell stack at 1000 ASF intermittently is impossible, a logical approach would be the load-leveled version with approximately the same economics as the redesigned SPE vehicle.

Table F-2. Impact of Load-Leveling on Vehicle Components

Vehicle	Curb weight, kg	Fuel cell weight, kg	Cost, $	Battery weight, kg	Cost, $
Solid polymer electrolyte[a]	1205	216	7340	NA	NA
Load-leveled solid polymer electrolyte	1243	153	6600	120	800
Load-leveled phosphoric acid	1598	227	8000	200	1330

[a]Redesigned, using 1000 ASF intermittently.

REFERENCES

F-1. General Electric Corporation, "Feasibility Study of SPE Fuel-Cell Power Plant for Automotive Applications," Los Alamos National Laboratory, Los Alamos, New Mexico, LANL Contract 4-L61-3863V-1, November 1981.

F-2. United Technologies Power Systems, "Assessment of Phosphoric Acid Fuel Cell for Vehicular Power Systems," Los Alamos National Laboratory, Los Alamos, New Mexico, LANL Contract 4-L61-3862V-1, March 1982.

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